LAND-FORMS AND LIFE

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SHORT STUDIES ON TOPOGRAPHICAL MAPS

BY

C. C. CARTER

M.A., F.R.G.S.

FORMERLY LECTURER IN THE SCHOOL OF GEOGRAPHY,
UNIVERSITY OF OXFORD,
AND ASSISTANT MASTER AT MARLBOROUGH
COLLEGE
EDITOR 'THE WORLD OF MAN' GEOGRAPHIES

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INTRODUCTION

THE aim of this book is simply stated. The ideal way in which to study land-forms and life is face to face. For schools—and for most of us—such perfection is impossible, except to a very limited degree. The next best way is by looking behind the finest topographical maps available. These studies are an attempt to foster a more sensitive appreciation of geographical realities by presenting common types of mainly British landscapes and the life associated with them. It is with the idea of care in my mind that I have narrowed down most of the sheets to selected districts. The book is intended for use in schools.

School geography is faced with limited time and limited money. Readers who will persevere to read the two sections below on " Courses " and " Equipment " will see that I have done my best—I hope successfully—to counter both difficulties.

These studies were written some five or six years ago for private use ; but the power of the topographical map, as an essential tool, is being increasingly recognised, and in a recent course for teachers they created a wholly unexpected interest. I offer them therefore in the hope that they may be found helpful in a wider circle.

In ranging over so many small districts, I fear that mistakes are inevitable. It will be obvious that some regions are less familiar than others. I shall be very

grateful to anyone who will be kind enough to point out to me if misplaced emphasis or other errors have crept in anywhere.

C. C. CARTER.

MARLBOROUGH, WILTS.

SUGGESTED COURSES

The best course is the one which the teacher plans out to fit his or her own need or own neighbourhood, when the material is known. But at the outset two or three suggestions may be helpful.

The course conducive to the most fruitful results will be one which extends the work over several stages of the school. This spread-over method, moreover, will go a long way towards solving the problem of limited time.

Some Sections are easier than others and can be intelligently absorbed by quite young learners. Such are those composing Parts V and VI on Coast Forms and Coast Life. Other simple Sections are the *Rhône Delta*, the *Culbin Sandhills*, *Vesuvius* and *A Chapter in Lake History*. Still others would be equally appropriate if the teacher is not afraid to omit paragraphs. The sooner the young learner can be got on to the map habit, the better.

But a thoughtful teacher will find many ways in which the studies can be used. For instance, they can be apportioned to the year's work of successive grades by selection or Part by Part; they can be employed either to inaugurate

a study of land-forms or of general human geography, to illustrate a course already in being or to freshen and consolidate revision work.

Although there is much to be said for grouping separately the physical and the human studies, as is done here (since one thing at a time makes for precision and since, further, the most suitable order for the two is not identical), there is also much to be said for following up a landscape picture immediately with its own human associations. If a long gap of time is likely to occur, for instance, between Parts III and IV or between Parts V and VI, probably the latter method will be most effective; the general drift of the separate physical and human Parts can be pulled together at some time. Alternatively, of course, the order of the book can be followed, if each physical background is rapidly revised before proceeding to human adjustments.

EQUIPMENT OF MAPS

Since this book was first published the Ordnance Survey Popular Edition has been replaced by the New Popular Edition with changed boundaries and new numbering. Similarly, Messrs. Bartholomew have withdrawn their Reduced Survey and issued the Half-Inch Series, Great Britain. In the table on page ix, the respective references to the old and new series of maps will be found set out side by side.

THE COST OF THE MAPS.—Very substantial discounts are granted, both by the Ordnance Survey and by Messrs.

Bartholomew, when maps are bought for educational purposes. Details should be obtained direct from the Ordnance Survey Office, Leatherhead Road, Chessington, Surrey, concerning their maps, and from Frederick Warne & Co. Ltd., Chandos House, Bedford Court, Bedford Street, W.C. 2, who are the agents for Messrs. Bartholomew.

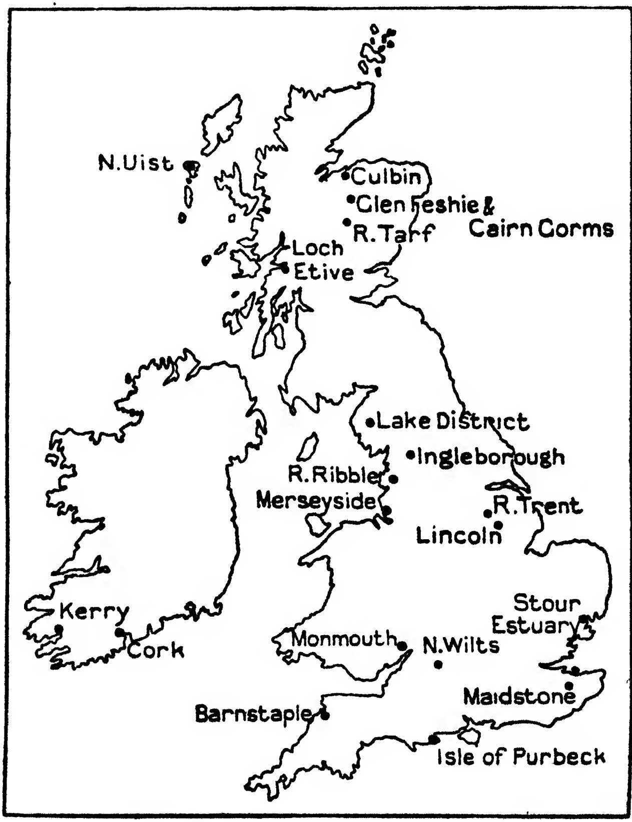
FOREIGN MAPS

During the years since the last war an increasingly large number of foreign maps have been available in this country. The final choice would best be left to the teacher, but the small table below shows the original foreign maps chosen for use with this book, together with a more recent alternative choice. Inquiries on this point may be directed to Messrs. E. Stanford Ltd., 12 Longacre, London, W.C. 2.

No. 73 (Fra., 1/200,000) Montpellier . 184 (Italy, 1/100,000) Napoli .	{12·0, 13·0} (Fra., 1/100,000). GSGS 4230, General Staff Map (1/250,000)
(Austria Staff Map, 1/200,000) Zara	Y22 General Staff Map (1/250,000)

OLD STYLE	NEW STYLE
O.S. POPULAR EDN., 1-INCH	O.S. NEW POPULAR EDN., 1-INCH
ENGLAND No. 20 Kirkby Lonsdale and Hawes 29 Preston 35 Liverpool and District 46 The Dukeries 47 Lincoln 87 Ipswich 98 Clacton-on-Sea and Harwich 102 Newport (Mon.) and District 112 Devizes and Marlborough (Special hachured sheet) 118 Barnstaple and Exmore 141 Bournemouth and Swanage	ENGLAND No. 89 Kendal. 90 Hawes. 94 Preston. 100 Liverpool. 113 Lincoln and Grantham. 150 Ipswich. 154 Cardiff. 155 Newport. 157 Swindon. 167 Salisbury. 163 Barnstaple. 178 Bournemouth. 179 Weymouth.
SCOTLAND No. 28 Nairn and Cromarty	SCOTLAND No. 28 Nairn and Cromarty.
O.S. COLOURED EDN., 1-INCH SCOTLAND No. 64 Kingussie	SCOTLAND No. 43 Kingussie. (Or Bartholomew's ½" G.B. No. 51 Grampians.)
O.S. COLOURED EDN., ½-INCH North Uist	SCOTLAND Nos. 22/23 North Uist. (Or O/S ½" No. 10 North Uist.
BARTHOLOMEW REDUCED SURVEY ENGLAND No. 3 Cumberland 30/31 Maidstone SCOTLAND No. 11 Oban	ENGLAND No. 82 Cumberland. (Or Bart. ½" G.B. No. 34 Lake District.) Bart. ½" G.B. No. 10 Kent. Bart. ½" G.B. No. 47 Oban. (Or O/S 1" Scotland Nos. 60/61 Argyll.)
BARTHOLOMEW REDUCED SURVEY ½" IRELAND No. 5 Cork and Kerry	BARTHOLOMEW ½" IRELAND No. 4 Cork and Kerry.

Equipment by Instalments.—I have tried to help the school that prefers to buy its maps by instalments. The Human Studies of Part VI are based on the maps of



MAP SHOWING SELECTED DISTRICTS

Part V, with the addition of the Liverpool Sheet; similarly, I have focused the human studies of Part IV on the maps of Part III, so far as I could. Either set of maps, therefore, forms a nearly complete series of physical and human studies.

Or, of course, the British Maps can be bought first and the more expensive foreign ones later.

THE CHOICE OF MAPS, subject to the purpose in view, was guided by three considerations:—(1) to introduce variety of styles, contoured, layered, shaded, hachured, British and foreign; (2) to give work with a variety of scales, 1/63,360 (an inch to the mile), 1/126,720 (a half-inch to the mile), 1/253,440 (a quarter-inch to the mile), 1/100,000, 1/200,000; (3) to keep down costs by choosing, as far as possible, one sheet for two or more purposes; thus the Kingussie Sheet illustrates both river piracy and the work of valley glaciers; the Hawes Sheet illustrates horizontal forms, a limestone region and water-seeking settlement. Even so, the original plan had to be considerably modified on the score of expense. The diagram on the page opposite shows the names of towns or other features round which the Selected Districts centre.

ACKNOWLEDGMENTS

As these map studies were written over a considerable period for private use, no special note of sources of information was made at the time. The *Memoirs of the Geological Survey* are implied in nearly every case and I hope that the references named at the end of each Section complete my obligations. But, if any writer finds that I have used material without acknowledgment, I can only plead for indulgent consideration.

To A. Garnett's *The Geographical Interpretation of Topographical Maps* I am indebted for ideas that have helped me when re-writing some of the human sections. Nor can anyone write of Scotland without turning to Geikie's *Scenery of Scotland*.

Illustrations which are copyright are acknowledged each in its appropriate place except that the following figures,

based on H.M. Geological and Ordnance Surveys, are published with the sanction of the Controller, H.M. Stationery Office, London: 15, 17, 19, 20, 21, 24, 26, 28, 29, 33-41. Figures 22 and 23 are reproduced by per mission of the Controller, Stationery Office, Dublin. Figures 14 and 27 are after W. M. Davis, and 30 after J. E. Marr. Figure 31 is based on the Atlas of England and Wales by Messrs. Batholomew & Co. with their permission. I would like to express my gratitude to Dr. A. Gilligan of Leeds University, to Dr. F. J. North of the National Museum of Wales, and to Messrs. Abraham, Ltd., of Keswick, who did not seem to mind how much trouble they took in helping me. A very special word of thanks is due to Messrs. O. G. S. Crawford, Alexander Keiller and the Oxford University Press for allowing me to reproduce from *Wessex in the Air* their magnificent view of Avebury.

I am also indebted to H.M. Geological Survey for permission to reproduce the following photographs:—Plates III B, IV A and B, XIII A, and XIV A and B, and to Messrs. G. P. Abraham, Ltd., of Keswick, for Plates IX A and B, X A and B, and XII A. Other acknowledgments will be found under the illustrations.

I am heavily in debt to my colleagues, Mr. H. C. Brentnall and Mr. E. C. Marchant, who read the manuscript and helped me from first to last. I am very grateful also to J. D. Purcell and other members of my form for offering me many of the quotations that stand at the heads of the Sections. Lastly, but very far from least, I would thank my publishers, who have left no stone unturned to reduce the cost of the map equipment.

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[*These illustrations are now grouped together following the end of the text on page 258, and before the Index*]

DIAGRAMS IN THE TEXT

Every educated person knows, in a sense, how the surface of England is modelled . . . but few persons conceive it with any imaginative energy or with the delight such energy brings. The rest have the kind of knowledge that lies dead in the mind. . . . It has to be raised from the dead by some evocatory miracle of appeal. . . . Thus does the large-scale map woo the susceptible mind.

C. E. MONTAGUE: *The Right Place.*

PART I

THE MAP

SECTION I

THE PROBLEM OF THE REPRESENTATION OF RELIEF

> But thou at home, without or tide or gale,
> Canst in thy map securely sail,
> Seeing those painted countries, and so guess
> By those fine shades their substances;
> And, from thy compass taking small advice,
> Buy'st travel at the lowest price.
>
> HERRICK: *Sailing on the Map.*

Difficulties of the Map-Maker.—A good map abounds in information and teems with interest. Even if it cannot present a complete image of an actual scene or a full record of human activities, yet some of its subject-matter emerges conspicuous and certain, while for the rest, like an artist's picture, it presents a background that is often brimful of suggestion.

The ambition of the map-maker is to create a picture and a record as complete and suggestive as the materials with which he is working will allow. He is, however, beset by problems. The first, and perhaps the most important, is the representation of the relief of the surface. It is a problem that has long taxed and still taxes the skill of the designer and of the craftsman. They have to represent three dimensions in two. Not only are they trying to show the broad features of highland masses and their absolute height above sea-level, but they aim also to indicate clearly the relative heights of highland and lowland. They would also delineate something of the detail of form as determined by the nature of the rocks and their arrangement, as well as those differences produced by denuding agents of different kinds. There are further difficulties. If relief

were drawn in exact proportion of height to length and breadth, this mathematical accuracy would give a sense of flatness, while the ordinary observer, looking from close quarters, sees roughness. Moreover, whereas an observer looks horizontally, or nearly so, at an actual landscape, he looks at a map (that is, a representation of that landscape) from a viewpoint vertically above.

Several methods have been designed to meet these difficulties. They may be grouped under two heads, *pictorial methods* and *mathematical methods.*

Pictorial Methods have for their aim truth of impression. Their chief tools are hachures, shading, light and shade, colour.

Hachures are fine-drawn lines, down the slope. On six-inch maps, like that of the so-called Isle of Purbeck round Lulworth Cove, they are generally drawn thicker at the top than at the bottom, and for steep slopes they are thicker and closer together; they splay out and tail off towards the bottom of the slope. On the above-mentioned sheet they are useful in showing clearly the steep drops and terraces due to the frequent landslips.

In general, their value is limited. Used by themselves, as on the old one-inch maps of the Ordnance Survey, they give an effective picture with some idea of relative steepness of slopes, dark for steep slopes, light for gentle, and blank white for flatness (whether low down or high up). But hachures take a long time to draw and are therefore costly, and they obscure other information, especially in hilly regions; it is for the latter reason that the Vesuvius Sheet is not easy to read.

Hachures, however, have the advantage that all slopes are represented, although not as viewed by the observer, who generally sees only the nearside slope. But their chief value lies in their power to delineate underfeatures which are omitted by the wide vertical interval between contour lines, details such as the landslips mentioned above,

shallow valleys and small knolls, which may be of paramount importance in a flat country such as Fenland.

Shading is done with a brush or stump and appears on the map as stippling—that is, dots—the steeper the slope, the closer the dots, and therefore the darker the shading. The general effect is much the same as that produced by hachuring, but the method is easier, quicker and cheaper. With both shading and hachuring it is not always easy to distinguish between ridge and valley, uphill and down. This is particularly true of our chalk lands and is illustrated by the Marlborough Sheet, where there are many spurs and streamless "Bottoms"; but the floor of a dry valley can often be traced by the white streak which separates the meeting hachures of the two valley flanks.

Light and Shade are effects obtained from oblique lighting. With hachuring and stippling the shading depends only on the degree of slope. Shade is here used in a different sense, the shade cast by objects. In British and other maps the lighting is imagined as coming from a low-down sun beyond the north-west corner of the map, as might be the case towards sunset in the summer. Slopes facing north-west will be in the light, and those facing south-east will be in the shadow.

This method produces a strong effect of relief, but it gives no idea of the comparative steepness of slopes. Indeed it is deceptive, for the slope in the shadow always appears as the steeper. Conversely, if a ridge of hills is oriented from north-west to south-east—that is, "end on," as it were, to the sun—the two slopes will be equally lighted and therefore will appear the same, whether they are or not. Further, parts of flat surfaces may be in the shadow, in which case they will appear as slopes. The effects of oblique lighting may be seen on the French map of the Rhône Delta.

Mathematical Methods have for their aim truth of fact. Their chief tools are spot-heights and contour lines,

with form-lines and the layer-system which are amplifications of the latter.

Spot-heights are absolute heights above sea-level. They appear on the map as dots, followed by the number of feet or metres of altitude. They are points exactly fixed by the surveyors and they generally run in lines—along a ridge, along cliffs of the sea-coast, along a road. It may be noted that the tendency is to mark them along summits rather than along the floors of depressions. They cannot by themselves give an idea of the relief.

Contours are lines on a map, representing imaginary lines on the ground, which join up a series of points of the same height above sea-level. They are based on a large number of points instrumentally fixed. Contours therefore are exact and may be considered the standard method of representing relief. From them accurate deductions of form, slope and visibility can be drawn, and with a little experience and patience the general outline of the relief can be easily read. They are simple and rapid for the draughtsman and they need not obscure other detail. But the field work is slow and therefore costly.

Moreover, contours have their limitations. Especially in ground of faint relief, where a slight rise may be of great importance, they fail, unless drawn at very close intervals (25 feet or less), and for the same reason they fail to show up minor features in regions of pronounced relief. There is in the Coloured Edition a 25-foot contour on the Preston Sheet (south of the Lower Ribble), and on the Lincoln Sheet (east of the Trent), but the lowest contour is usually at 50 feet.

Contours are most effective on the larger scales of the topographical maps, the one-inch or the half-inch to the mile. On the smaller scales such wide vertical intervals have to be chosen, that major features are often omitted and curves are smoothed out. For instance, the International Map on the scale of one-millionth can give only a very general impression.

Contours should be at uniform vertical intervals. On the Coloured Edition of the one-inch sheets of the Ordnance Survey the heights chosen are 50 feet, 100 feet, and then by hundreds up to 1000 feet; after 1000 feet the interval is increased to 250 feet, that is, at 1250, 1500, 1750 and so on. The reasons generally given are the high cost in highland regions and the danger of obscuring details on the map by the necessarily close contours. But this change of interval is a weakness; for one cannot visualise two scales at the same moment, and the reality is left as a lessening instead of the usual steepening slope at higher levels. On the one-inch maps of the Popular and Tourist Editions, however, each intervening 50-foot contour (form-line) has been inserted, and even above 1000 feet the contour interval continues at every 50 feet. Where the contrasts of relief are sharp, as in the mountain country of Monmouth with its deep, narrow valleys, the closer contour interval of these "Popular" maps offers good examples of what contours alone can do to show up the relief. Further, ease of reading is increased; for at 500 feet, and at every multiple of it, the contour line is stressed by being drawn with a heavier line. Other excellent examples of the clear picture offered by contours at frequent intervals may be seen in the Appalachian and other sheets of the United States Geological Survey; here the intervals are 100 feet, but with every intervening 10 feet sketched in and shown by fainter lines.

Sea Contours are given on British maps for high and low tide, and coast features are excellently shown up by the improved colours adopted for the Popular Edition. Submarine contours are generally at five fathom intervals, though sometimes they seem to be in feet; for instance, the submarine contours on the Barnstaple and Nairn (Culbin Sands) Sheets are in fathoms, but on the Loch Etive and District Sheet of the Coloured Edition, they are in feet. On this last map it may be noticed that, while in the sea-inlets of Lochs Etive and Creran submarine

contours are marked, they are omitted in the inland Loch Awe.

Form - lines are approximate contours. They are sketched in by eye, not instrumentally fixed, and interpolated between the exactly fixed contours. On the French sheet of the Rhône Delta they are shown as broken lines, and this method seems preferable to the British, where they are indistinguishable from true contours. Form-lines are useful to show up detail, which the contours may not bring out.

The Layer System, like the form-line, is merely a development of the contour method. Tints of colour, graduated according to height, fill the inter-contour spaces. This makes for easy and rapid reading; it is a great advance, made possible by the progress of colour printing in recent years. Printing costs, however, are high owing to the number of times the map has to pass through the press. It was first popularised by Mr. Bartholomew of Edinburgh in his half-inch "Reduced Survey" series. It is now commonly employed in atlas maps and on wall maps. In the latter the pioneer was von Sydow of Gotha; he used green, white and brown in ascending order and supplemented with hachures. Philip's Comparative Series of wall maps are on the same system, though not with the same colours. A beautiful example of a wall map is Bartholomew's Scotland, and of atlases Bartholomew's England and Wales on a scale of half an inch to the mile, a similar atlas of Scotland and the so-called Times Atlas (by Bartholomew) are outstanding triumphs of the use of the layer colouring.

The choice of colours is important, since abrupt contrasts give a step-like appearance. The convention as to colouring maps is—the more intense the feature, the darker the colour—but the number of tints of one colour must be limited to avoid obscuring detail. Hence it is necessary to use tints of two or more colours. In his atlas of England and Wales Mr. Bartholomew uses four tints of green,

twelve of brown and two of purple to reach the top of Snowdon (3600 feet); in his atlas of Scotland, four of green, fourteen of brown, and then two of white to reach the top of Ben Nevis (4400 feet). On the Oban Sheet he uses two of green and twelve of brown, and here it will be noted that, as is usual, the order of the greens is reversed; they lighten with height in order to tone in with the lighter browns. The combination of colours is both effective and pleasing.

Combination of Methods.—Most maps use several systems in combination. The Coloured Edition of the one-inch maps of the Ordnance Survey uses contours, spot-heights and hachures; the Popular Edition uses contours, form-lines and spot-heights. The new French map on the scale of 1/50,000 (Rhône Delta Sheet) has contours, shading, light and shade from oblique illumination, and spot-heights.

The most ambitious maps are probably the above-mentioned French sheets and some of the special "Tourist" Edition of the British one-inch sheets, such as Killarney, the Lake District, and Snowdon. They should be examined to note how the colour gradations melt into one another, how both contours and hachures, though subdued, are yet clear and easy to read. The above maps give the relief almost with the vividness of a raised model, and from an artistic point of view they are a joy to look upon. The "Tourist" Sheets are being steadily multiplied; there are now twenty-three of them published, but not all have the hachures or the same delicacy of colour.

Reference.—A. R. Hinks: *Maps and Survey* (Cambridge Press).

SECTION II

THE ATLAS

I teach them from a bloodless book
  To scan a bloodless chart,
And pray one day their eyes may look
  To find the throbbing heart.

G. D. Martineau: *Geography.*

The Atlas.—Advertisers do not err on the side of understatement, but a map-making firm exaggerated not at all when it claimed that an atlas was "guide, philosopher and friend." Every student should become not merely acquainted but intimately familiar with such a library. Here we are concerned only with the relief maps and their orographic colouring. It is not possible to suggest anything except in general terms, but in the light of the following paragraphs the learner should examine his own atlas, until he or she has obtained a sure grip of its particular features. Through his atlas he should apply the lessons learnt in these local studies to the greater conditions of the world at large. In working through the "Other Large Scale Illustrations" and "Atlas Examples" he will find useful Bartholomew's Times Atlas, the same cartographer's Atlas of Scotland and Survey Atlas of England, if they are available.

Relief Maps of the Continents. — All good British atlases now show the heights of the land and the depths of the sea by "layer systems." Four standard levels, for heights and depths alike, are 600, 3000, 6000, and 12,000 feet. An intermediate contour is usually inserted in the neighbourhood of 1200 feet (1000, 1200 or 1500), while on the map of Asia 18,000 feet serves to distinguish the

permanent snow and rock wastes of the Himalayan and Kunlun ramparts of Tibet.

Apart from these supplementary contours, the four critical lines may be regarded as roughly distinguishing vertical belts into lowlands, uplands, highlands, (what may be perhaps called) toplands, and uninhabited mountain wastes. With such a classification applied to Africa, for instance, the lowlands are restricted to a narrow coast margin; the north-western half consists mainly of the low tablelands and upland basins of the Sahara and the Sudan, while the south-eastern half might be divided by ascending height into the South African Tableland near the lower limit of highlands, the Kenya Tableland near the upper limit, and the Abyssinian Topland.

Four such inhabited toplands would be distinguished, two in the Old World and two in the New—Tibet and Abyssinia in the former, and in the latter that part of the Andean Cordillera covered politically by Ecuador, and that covered by Peru and Bolivia (Titicaca Topland).

The usual colours employed are green up to 600 feet, rising through yellows and browns to a variety of colours at higher levels, red, slate, white and others.

Land areas that lie below the level of the sea are also distinguished by a deep tint of green. The chief of these are the trench of the Jordan, in which the surface of the Dead Sea is more than 1300 feet below the level of the Mediterranean, the flats round the northern end of the shrinking Caspian Sea, and, most usefully of all, the empoldered (dyked) lands of the western provinces of the Netherlands (North Holland, South Holland, Zeeland).

Relief Maps of Regions.—In the regional maps, as distinct from the continental, one might expect that these same standard contour levels would be used, with several supplementary lines added for the subdivisions of the lower levels. But there are variations of practice. In Messrs. Philip's Advanced and Modern School Atlases the

standard levels are uniformly used, except that over 3000 feet distinctions of height are ignored, the whole is coloured brown, and reliance is placed on hachures to show up the main mountain ranges. The effect is to concentrate more closely upon lowlands and uplands. In the maps of the British Isles the 300-foot contour is usefully added.

While in Messrs. Relfe Bros.' New Aldersgate Atlas (with maps by Mr. Bartholomew) the choice of levels is uniform through the continental maps, on the maps of the Oxford Advanced Atlas, by the same cartographer, the critical levels vary, no doubt with the object of emphasising more effectively the relief divisions individual to each continent. For the Old World of Eurasia and Africa the distinctive levels chosen for the continents are the usual 600, (1500), 3000, 6000, and 12,000 (except Europe 10,000) feet, but for the Americas and Australia the heights taken change to 500, 1000, 2000, and moreover above the 2000 no two of the three are alike. In the regional maps, India and China have the same levels as Asia; the former has also additional lines at 1000 and 2000 feet, which serve to bring out the northern bulwarks of the Dekkan and other details of important significance. Again, while the map of the North-eastern United States preserves the continental contours with additions at 500, 1000 and 2000 feet, the map of Southern Canada and the United States differs from the continental map of North America in every level except 6000 feet and returns to the usual 600 (1500), 3000, 6000, (9000) and 12,000 feet.

Submarine Relief.—The maps of the continents show submarine contours at 600, 3000, 6000 and 12,000 feet, as has been mentioned above. The colour gradation is white down to 600 feet, which serves to show the limits of the continental shelves, followed by deepening tints of blue. By this means are shown up many features of great geographical importance. The inshore shelves off eastern

North and South America are unmatched on the west coasts where the Pacific Cordillera plunges immediately to great depths ; the shallow fishing Banks off Newfoundland, the Maritime Provinces of Canada and New England contrast with the profound depths that flank Hispaniola and Puerto Rico on their northern sides. Island groups, like the British Isles, emerging from the shallow waters of continental shelves, reveal themselves as detached fragments of their continental neighbours ; such too the atlas shows to be the case for Ceylon, Tasmania and New Guinea. These "continental" island groups contrast with the island chains that represent the undrowned summits of deeply submerged mountain ridges, like the East and West Indies and that whole succession of island-crescents that blanket the eastern margins of Asia and Australia ; they contrast again with Mauritius, Samoa or Hawaii and other isolated volcanic islands that rise, detached and alone, from the ocean floors. The seas themselves differ. The North Sea is shallow, the Norwegian Sea is deep ; the gently sagging Baltic Basin is less than 600 feet deep, while the Mediterranean is over a mile ; Hudson Bay differs from the Gulf of Mexico, the Persian Gulf from the Red Sea, and the East China Sea from the Sea of Japan.

SECTION III

OROGRAPHIC PORTRAITURE

You learn, like a portrait-painter, to penetrate by the help of intuitive inference: you get at one thing through another.

C. E. MONTAGUE: *The Right Place.*

Contour Lines as Symbols.—Words are merely labels for things and ideas. So contours are nothing more than symbols, map-symbols for landscapes and their build. The map-lover sees through the symbol to the reality for which it stands. Like a portrait-painter, he learns to penetrate by knowledge, intuition and inference. Like the musician, who hears through the notes of a musical score "the rise and fall of an air, the jaunty lilt or triumphant rush or plaintive trail of its gait, its swelling loudness or shrunken whisper," he is "freed, before long, from the need of going through a conscious act of interpretation. . . . The symbols once learnt, the map conveys its own import with an immediateness and vivacity comparable" with that of the score of a piece of music.

Doubtless, as in learning to read, the first steps are slow—line by line, group by group, form by form—until one seizes a whole landscape with rapidity.

For the detailed study of map-reading the student must be referred to special books on the subject, such as Mr. E. D. Laborde's *Popular Map-reading* (Cambridge Press). But, since certain patterns frequently recur, it is worth while at the outset to link up a few typical contour designs with the surface forms which they reveal.

Slopes and their Contoured Expression.—A little thought will make it obvious that close contours spell steep slopes,

wide-spaced contours spell gentle slopes. This helps further to distinguish the three types of slope, uniform, concave, convex (Fig. 1). Contours at equal horizontal distances apart imply a uniform slope; contours wide-spaced at the bottom and closing together towards the top mean a concave slope. Contours close at the bottom and spacing out towards the top mean a convex slope. Most slopes are convex at the top and concave at the bottom, but the general profile curve along a water-

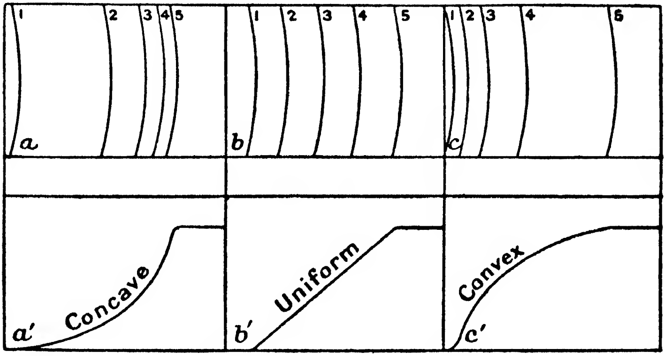

FIG. 1.—SLOPES

course is nearly always concave, while the slope down the length of a spur is nearly always convex.

The rambler over the map may sometimes save himself from error if he remembers that he cannot change slope, that is, from up to down or down to up, without crossing *two* contours of the same denomination.

Slopes may steepen to precipitous walls and then the contours will lie one on the top of the other. Such may occur in corries, perpendicular sea-cliffs or quarries (Fig. 2). In such cases the map generally aids the reader by special shading. Slopes may rise as well as fall to level stretches, as on parts of the Downs, the Cairngorms, table-mountains and elsewhere. The white blanks of the map-sheet express this flatness, but the student should be on his

guard against rushing to the conclusion that white blank spaces are necessarily low-lying.

The map-lover, however, would wish to go further and visualise the steepness or otherwise of slopes with a reasonable degree of accuracy. He can work out on a map of the one-inch scale, with contours at 50-foot vertical intervals, that contours spaced a quarter of an inch apart mean a slope of 50 feet in a quarter of a mile=50 feet in 1320 feet=1 in 26; similarly, contours a fifth of an inch

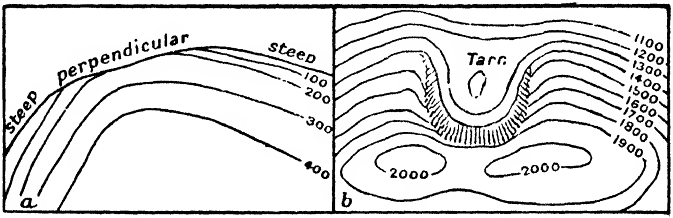

FIG. 2.—(*a*) SEA CLIFFS. (*b*) A CORRIE

apart mean a slope of 1 in 21 and so on. But, if these gradients are to mean anything real, the student should go out, measure and fix in his mind's eye two or three slopes along roads or elsewhere as standards of comparison. For this purpose he will need a clinometer (which can be home-made with a protractor and a plumb-bob) and a knowledge of the Triangle of Reference.

The Triangle of Reference.—The accompanying Fig. 3 is called the Triangle of Reference. A B is the slope of the ground and the distance A C is its Horizontal Equivalent (H.E., for short) as expressed on a map. B C is the vertical measurement of the rise or fall in passing between A and B, is called the Vertical Interval (V.I., for short), and is measurable on a map by means of the contours and spot-heights. The angle C A B is the Angle of Slope and is measurable on the ground by means of a clinometer or slope-measurer. For small angles of slope—say up to

10 degrees—the ground distance along the slope and its horizontal equivalent may be regarded as equal.

Now it is found by practical experiment that, when the angle of slope (C A B) is 1 degree, the rise is 1 foot (V.I.) in a ground distance of 60 feet (A B), which equals A C. In other words, when the angle of slope is 1 degree, the gradient is 1/60 (1 in 60), and similarly, when the angle of slope is 5 degrees, the gradient is 5/60=1/12. Conversely, when the rise or fall is 1/60, the angle of slope is 1 degree, and, similarly, when the gradients are 1/12

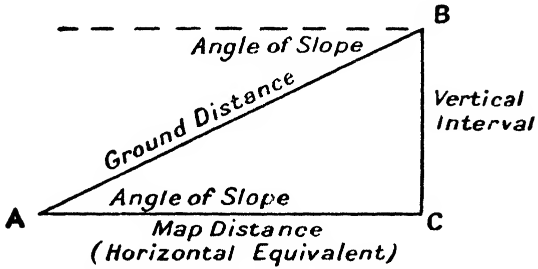

FIG. 3.—THE TRIANGLE OF REFERENCE

(=5/60), 1/15 (=4/60) or 1/20 (=3/60), the angles are 5 degrees, 4 degrees and 3 degrees respectively.

Knolls and Hollows, Summits and Cols are expressed by circular, elongated or irregular ring contours. Knolls, often formed by mounds of more resistant gravel, are important when they rise, like islands, from the wet levels of fenlands, flood plains or other flats; they suggest dry, sloping sites for settlement or view-points for surveyors' trigonometrical stations (Fig. 4a). Ring contours are characteristic too in regions of sand-hills; in this case they are probably elongated in form, at right angles to the prevailing wind, and are arranged in roughly parallel bands as in Fig. 4b. Examples of the first type will be found on the sheet of the Lower Trent and of the second on the Nairn and the Ilfracombe Sheets.

Ring contours, representing basins or hollows, are less frequent, as basins are mostly filled with lakes, and the under-water contours of lakes are not given on the Ordnance or Bartholomew maps, although British lakes have

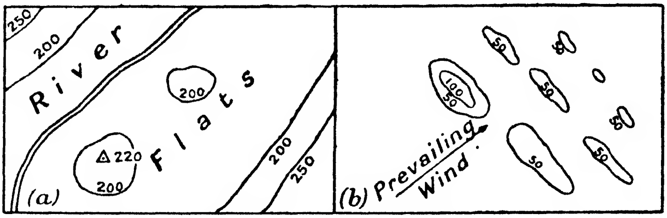

FIG. 4.—(*a*) KNOLLS. (*b*) SAND-DUNES

been carefully surveyed. The atlas, however, may give one or two clear examples: the depression of the Turfan Oasis in Central Asia, the basins of Seistan and of the Lut " Oven " in Eastern Persia, Death Valley and the Salton Sea Basin in Southern California, the Fayum and other oases west of the Nile.

The undulating crest-line of a ridge shows a succession of ring contours where it rises into summits separated by

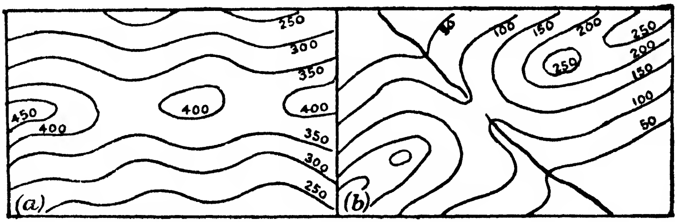

FIG. 5.—(*a*) COLS AND SUMMITS. (*b*) A SADDLE

shallow saddles or cols (Fig. 5a); they deepen here and there into pronounced saddles and gaps as in Fig. 5b. In closely settled country the deeper saddles and gaps may be rapidly identified by the transverse roads that seek their lower levels and easier gradients. Yet such physical guidance is not to be assumed for certain. Sometimes the

valleys are steep-headed and do not notch the summit, so that the roads climb by the spurs ; such cases are frequent in the Chalk Downland of the Maidstone and Marlborough Sheets and are matched on a larger scale in the Blue Mountains of New South Wales, the crossing of which from Sydney to the interior plains was long delayed.

Spurs and Valleys.—The contour groupings in Fig. 6a and 6b spell spurs and valleys. Fig. 6a is a simple case. A blunt spur of convex profile is shown by bulging or salient contours closing down-spur ; a narrow valley lies

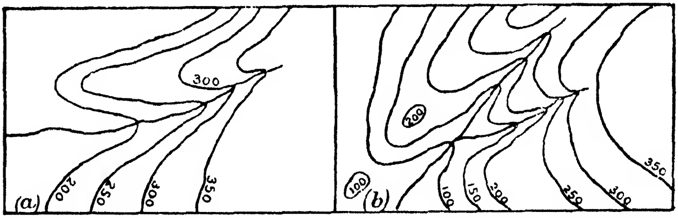

FIG. 6.—(*a*) SIMPLE SPUR AND VALLEY. (*b*) COMPLEX SPUR AND VALLEY

beneath with the normal concave profile of river erosion, for which the re-entrant contours " stab inwards pointedly to the heart of the hill," closing up-valley.

Fig. 6b is more complex. The pointed spur has a " pimple on its nose." The main valley has on the east a well-defined tributary valley in which the contour arrangement shows the same normal concave profile but, as is natural, with a steeper fall and shortened length. On the western flank a slight re-entrant kink suggests a shallow tributary valley, which supplementary shading might have shown up more distinctly.

In Figs. 7a and 7b the valley profiles are abnormal. The first consists of gently inclined reaches succeeded by rapid falls. This arrangement suggests immediately an ungraded stream, transverse bands of tough fibre or, possibly, the broken bedding of ice-erosion. In Fig. 7b

the stream rises high in a steep-walled arm-chair hollow—a cirque, cwm or corrie—and flows for some distance with gentle gradient until it breaks rapidly down a steep slope into the main valley below; it is the characteristic tributary " hanging valley " of a glaciated region.

Structural Forms.—It has been well said that " we do not know a mountain until its interior is to our mental eye as clear as crystal." Now the contour plan is not seldom suggestive of the underlying structure. At the same time restraint is necessary. For just as the look or bearing in a painted portrait may suggest, but not defi-

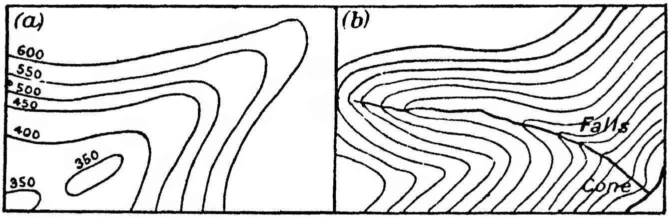

FIG. 7.—(*a*) A BROKEN-BEDDED VALLEY. (*b*) A HANGING VALLEY

nitely declare, the personality of the individual, so orographic portraiture can do no more than suggest the structural form. At any rate, even if they cannot give immediate and definite conclusions, contour patterns do narrow the inquiry, and often converging pieces of evidence may be derived from other sources on the map, until proof becomes irresistible. Such a case occurs with the table-mountains on the Hawes Sheet.

Horizontal and Inclined Forms.—The accompanying diagrams are of the forms to which horizontal and tilted strata give rise. The first (Fig. 8a) represents a flat-topped table-mountain standing on a broad platform, both of which are suggestive of horizontal structure. Both the table-mountain and the platform drop by symmetrically steep edges or scarps. The second (Fig. 8b) shows a

tableland deeply trenched by a river and its tributary; the valleys are symmetrically sided.

In the next diagram (Fig. 9) the tilted strata give rise to a scarped ridge. Here the contour pattern marks the short, steep scarp by closely packed lines and the long,

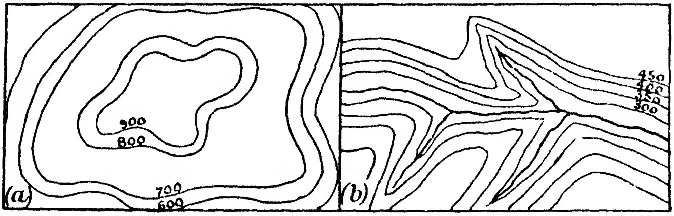

FIG. 8.—(*a*) A TABLE-MOUNTAIN ON A PLATFORM. (*b*) A TABLE-LAND DISSECTED BY GORGES

gentler dip-slope by lines more widely spaced. The former run comparatively straight, except for short ravines or rounded combes; out-lying ring contours would suggest residual " outliers " of the same rock, left behind as the undermined scarp recedes seawards. The latter are highly

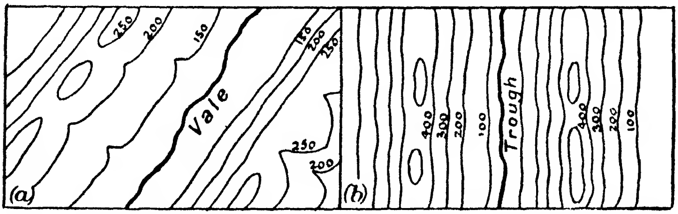

FIG. 9.—(*a*) SCARPED RIDGES AND VALES. (*b*) SYMMETRICAL RIDGES AND VALES

irregular; by deep re-entrants they show the valleys that dissect the dip-slope. The crest presents an even skyline, rising gently to summits and sinking to cols.

In Fig. 9b the strata are tilted at a steep angle and the asymmetrical form of the ordinary scarped ridge disappears; contour lines are equally spaced on either side.

Folded Forms.—Folding gives rise to parallel ridges and troughs which would be outlined by parallel contours. Here care is essential; for, in drawing deductions as to the structure, confusion might arise as between folded and inclined forms. If the folds were symmetrical, the contours would be equally spaced, as with the steeply-tilted strata of Fig. 9b. If the folds were steeper on one side than on the other, the contours might be similar to those of the scarped ridges of Fig. 9a. The parallelism of the contour plan therefore is no guide. But this much may be said. In England steeply folded forms are rare, the scarped ridges and vales of inclined strata are common. The crest lines of folds are frequently notched with lengthwise, canoe-shaped, anticlinal valleys, as in the Vale of Pewsey on the Marlborough Sheet and in South-west Ireland, and these show the two bounding scarps facing each other, while the scarps of inclined strata all face towards the same direction. Again, scarped ridges are distinguished from folded by frequent outliers, as already described.

Fault Scarps.—The steep scarps resulting from fracture and dislocation may be indistinguishable on the topographic map from the denuded scarps of inclined strata, but here outliers are less likely, at any rate at first (Fig. 10a).

Volcanic Cones and Lava Tablelands.—Volcanic forms are derived either from cones, which show concentric patterns (Fig. 10b) or from lava flows, which show the terraced, tabular patterns of horizontal stratification, as in some of the Inner Hebrides. Again, care is necessary. The cone-shaped rubbish dump of a volcanic explosion is not represented in the British Isles, although the "Laws" of Southern Scotland are old volcanic plugs and show concentric contour patterns for Largo Law and North Berwick Law. But it must be remembered that a square block of rock which is uniform in texture will wear comparatively rapidly near the summit and at the edges.

while the debris will cloak and soften the lower slopes, until the whole is reduced by normal weathering to a pyramidal form; such are many of the Beinns of Torridon Sandstone in Western Ross-shire round Lochs Torridon, Broom, and Maree. They do not, however, show the

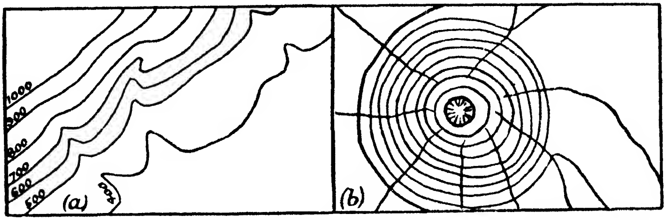

FIG. 10.—(a) PART OF A FAULT-SCARP. (b) A VOLCANIC CONE

sinking contours or precipitous shading of the volcanic crater, as do Vesuvius and the many examples in the Phlegraean Fields.

SECTION IV

THE GEOGRAPHICAL CYCLE

The hills are shadows, and they flow
    From form to form, and nothing stands;
    They melt like mist, the solid lands,
Like clouds they shape themselves and go.
TENNYSON: *In Memoriam.*

Surface Form—Its Threefold Aspect.—In order to obtain a complete mental picture of a part of the earth's surface it is necessary to visualise it in three aspects :—

(*a*) *Its Extent*; that is, its horizontal length and breadth as shown on a flat map.

(*b*) *Its Height*; that is, vertically, also shown on a map by means of contour lines or other methods, which enable generalised divisions into lowlands, uplands, highlands and toplands.

(*c*) *Its Surface Detail*, by which types may be compared and distinguished, and here the map tells us little. The form is the result of the nature and structural arrangement of the rocks, and the detail differs greatly according to the particular denuding agent that is or has been most active in working on it. The concentric contours of isolated mountains like Vesuvius, Taranaki (Mount Egmont) or Fuji may suggest the volcanic cone, but, in general, the map does not distinguish the characteristic detail of a highland mass or lowland basin; it tells little of the difference between the fractured block of the Central Plateau of France and the ridges and troughs of the Alps, or between the smoothed, bare, lumpy lowland of the Canadian Shield round Hudson Bay and the deep-soiled, level plains of Prairieland.

Forces at Work—Within and Without.—Two sets of forces are at work. One set, due to strains and stresses within the earth itself, produces movements on the earth's outer cover, tilting, folding and fracturing the rocks, or transfers material from interior to exterior. The other set, derived externally from the heat of the sun, sets in play the various activities of the atmosphere and surface agents, rivers, moving ice and wind and others; gravity is a silent but persistent ally.

Internal forces determine the larger features, continental blocks and ocean basins, highland masses and land basins. External forces modify these by carving on them lesser features. The former provide the material in the rough. The latter etch out detail of infinite variety. The one group brings into existence the great contrasts of elevation. The other seeks to soften and even obliterate that contrast by reducing the heights and filling the depths.

The Attack—Weathering and Erosion.—Denudation implies two processes—the breaking up of the rock surfaces and the removal of the debris, which in itself causes further destruction. The weapons, methods and results differ in different places and at different times. But, since moist climates are the most widespread over the world, chief attention will be paid to denudation under these conditions.

In the moist climate of the British Isles the rock surfaces crumble under the dispersed weathering action of a damp atmosphere, and the land waste is transported by rain wash and streams, to be dropped temporarily on flood plains and in lakes on the way to its final resting-place on the sea floor. To such mechanical work must be added chemical solution by the acids in percolating ground water, operative particularly in limestone regions such as the Chalk Downs and the limestone districts of the Pennines. The work of rivers is illustrated in Sections VI to

IX on the Monmouthshire rivers, the Ribble, the Trent, and the Rhône Delta; the results of chemical solution are illustrated in Sections XV and XVIII on the Ingleborough and Marlborough districts.

Cold regions, like Antarctica, Greenland and mountain summits, are marked by different characteristics due to the operation of other forces. Frost, freezing and swelling the water particles held in the rocks, prises grains apart and breaks off angular fragments. Ice-sheets and valley-glaciers carry and drive rocks and grit, grinding them still smaller, rasping and smoothing the rock beds over which they move and dumping the debris in lumpy heaps. This aspect is illustrated in Sections XI and XII on the sheets for North Uist and Kingussie; for, although the Glacial Epoch, when Britain lay under ice as far south as the Thames, has long since passed away, the effects remain to influence the landscape and the activities that are based on it.

In dry countries, like the Sahara, rapid changes of temperature and the sand-blast cause widespread havoc; the wind clears the debris and sweeps surfaces clean or piles a mass of sand-dunes. This is partly illustrated in Section XIII on the Nairnshire Sheet.

The Defence—The Nature and Structure of the Rocks.—The strength or weakness of the defence of the land against the attacking forces of denudation depends on the composition of the rocks and the structural arrangement of the strata.

A rock is resistant by composition when the elements of which it is composed are equally hard and are compactly squeezed or cemented together, so that the surface presents a firm front against attacking weapons; such resistant rocks are most of the igneous and metamorphic groups, like basalt and gneiss, and some of the limestones and sandstones. *A rock is weak*, however, when the particles of which it is composed are equally soft like clay, when one

of its elements is weak, as in the case of granite, or when they are only loosely bound together, like some sandstones. Weak, too, are many of the limestones, which are soluble in acidulated ground water.

A structure is resistant when its joints are few or are tightly pressed together. It is due to compressional forces that downfolds are strong to resist attack. On the other hand, *a structure is weak* when joints are many or fractures frequent ; for these allow the penetration of destructive agents. The crest lines of upfolds have their superficial joints opened by tensional strains and are therefore weak. Further, if a weak stratum is interbedded between stronger layers and is exposed to the surface, it is comparatively soon removed, and then the whole structure is weakened.

In fact, the relative position of highlands and lowlands, ridges and vales, promontories and bays is largely due, not so much to absolute resistance and weakness, as to the comparative strength of rock or structure in relation to neighbours.

The Geographical Cycle—The Stage.—The fundamental fact, then, is that the forms of the surface are not fixed ; they are not just there. Nature works in order, not in haphazard fashion. Surface forms are born, pass through a series of life stages—infancy, boyhood, adolescence, maturity and old age—to death, although for our present purpose we shall be content to recognise three such stages only and call them early, mature and late. There is thus a regular succession of changes, as highlands are reduced to lowlands, or as lowlands themselves are first ribbed out perhaps into ridge and vale and then smoothed into a plain of faint relief close to the base-level of the sea. The whole series of changes involved in the completion of this process is known as the Geographical Cycle. Into it present-day forms can be fitted, each in its appropriate place, with some approach to system. Other terms, sometimes used,

are Cycle of Land-forms, Cycle of Denudation and Cycle of Erosion.

The rate at which a land-mass goes through this cycle obviously must depend on the relationship between the vigour of the attack and the stoutness of the defence. The assignment of a land-form to its appropriate place in the Geographic Cycle is not a question of time but of the stage reached. And a grasp of the essential facts cannot but increase one's appreciation of a landscape, make easier and quicker the exploration of a district by indicating the critical points of observation, and shorten and clarify its scientific description.

Seen from this point of view, therefore, the relief of a region depends ultimately on three interwoven factors :—

(*a*) The particular destructive process and its vigour.

(*b*) The nature of the rocks and their structural arrangement, which determine the resisting powers.

(*c*) The stage of destruction reached—early, mature, late.

Reference. — W. M. Davis: *Geographical Essays*, chapters xii and xiii (Ginn).

SECTION V

THE GEOGRAPHICAL CYCLE IN THE BRITISH ISLES

> The sound of streams that swift or slow
> Draw down the Æonian hills and sow
> The dust of continents to be.
>
> TENNYSON: *In Memoriam.*

Birth.—Imagine that a land surface has been newly raised above the level of the sea and is so tilted that it slopes down fairly steeply from, say, north to south. Its surface will not be uniform; there will be sufficient undulations to guide the rain water into definite channels. Streams will be small and will flow to the sea as many independent individuals.

The Early Stage.—If gradients are steep, downward erosion by concentrated vigour along the channels is rapid, while dispersed weathering on the flanks is slow. Hence the essential characteristics at this early stage are simple.

Valley profiles are steep and ungraded. Although the volume of water is small, the current is rapid, is swollen many times over in times of heavy rain and is strong to do work with the mud, sand, pebbles and rocks which it is carrying in suspension or pushing along its bed. Original inequalities are not yet smoothed down. Quiet reaches alternate with falls and rapids, and hollows are filled to form lakes.

Cross-sections of the early valleys are often V-shaped, deep, narrow and steep-sided. The flanks fall steeply and directly to the stream with little or no flat ground along the floor (Fig. 11a, 2).

Tributaries are few and short with steep gradients.

Inter-stream areas are hardly touched by the work of the short tributaries or by dispersed weathering; they remain as undissected backs.

In the Mature Stage the main streams have advanced much further in their work of developing their valleys; they have also begun to be constructive by building flood-plains. The upper course may still show the characteristics of the early stage, but in mid-course lateral erosion has been added to that directly downward, and meanders are characteristic. Sapping extends the valley headwards.

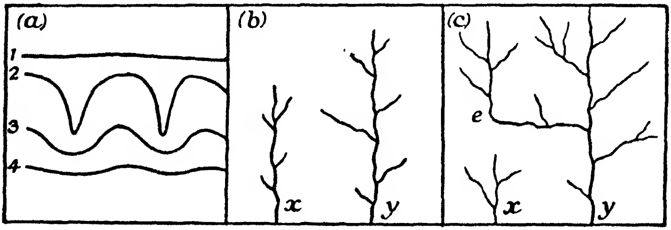

FIG. 11.—(*a*) VALLEY DEVELOPMENT. (*b*) RIVERS IN THE EARLY STAGE. (*c*) RIVERS IN THE LATE STAGE

The valley profile has been graded into a curve of steadily lessening steepness. This grading of the curve begins at the mouth owing to the greater volume of the river, and therefore the greater power of work, in its lower course; thence the flattening steadily works its way upstream. The river still continues to deepen its bed towards its base level, especially with the heavier particles which are pushed and rolled along the bottom.

The valley cross-section is widened. While erosion, directly downward, was paramount in the early stage and is still paramount in the upper course, in the middle course lateral erosion with the finer particles, which are carried in suspension, is added. The stream is characterised by swinging meanders, which, by undercutting the outer banks at every turn, are steadily widening its sweep. As

the concave banks migrate outwards, the inner grow in harmony ; for debris of shingle, sand and mud is dropped as growing flat tongues in the slacker water on the inside of the curves. Swinging meanders with interlocking spurs and flats, together with the beginning of constructive action on the flood plain, mark the valley course. Spur and concave bank have destroyed the symmetry of the V-shape of the early stage, and the valley has opened out (Fig. 11a, 3).

The tributaries themselves are developing their own valleys and their own network of feeders ; they have sapped their way headwards and lengthened their courses, until perhaps they have become considerable streams ; they pass through the same stages as the main river but lag a stage behind. The stronger may have so far extended their sources headwards that they have invaded the domain of weaker rivals, undercut and captured the upper waters of their neighbours ; thus they are strengthening themselves and leaving their competitors beheaded and shrunken. So streams are losing their single individuality and the many individuals of the early stage are becoming concentrated into a few large systems (Fig. 11b and c).

The inter-stream areas are now covered with a network of streams, so that the simple backs are being dissected into an intricate relief. The lowering of their height and the softening of their outlines are being accelerated, while the discharge of the rainfall, in times of stress especially, is more prompt and more efficient.

In the Late Stage the region is reduced to one of faint relief. The river has flattened out its curve by working from the mouth upwards. Falls and rapids have been cut out. Lakes have been filled up. Steep slopes and spurs have disappeared both from the main stream and from its feeders (Fig. 11a, 4).

The profile is gently graded and the current sluggish.

The cross-section is hardly discernible.

Tributaries are everywhere and contribute to a few large systems with divides blurred.

The inter-stream country is wholly a flat plain or of gentle undulation. Active erosion has ceased ; the stream can barely send on its water, so that flood surplus, though gathered promptly, is delayed in discharge. The river is building up its bed above the surrounding levels and shoals are frequent. All this makes widespread flood a danger, unless the river is disciplined between man-made embankments.

Last Scene of All, in which this eventful history might theoretically end, supposing that tectonic forces ceased to operate, would show a country planed to sea-level, the last vestiges of the ridges that once separated its water-courses just awash and swept by every tide; and the whole a dreary sea-marsh, the haunt of wading birds and crabs, sans streams, sans trees, sans shores, sans everything.

Rejuvenation.—It is not often that any region is allowed to complete its whole life-cycle without interruptions. A land surface, like a human being, is subject to accident and illness—what a recent writer has called the chills of an Ice Age, the fevers of volcanic outbursts and the shivering fits of earthquakes. The most frequent cause of such alteration of conditions is change in land-levels with respect to sea-level. For instance, a land surface that has almost passed through its life-cycle and is approaching a gently undulating lowland near the base-level of the sea may be re-uplifted. It becomes a level-topped highland. In a moist region its rivers are re-

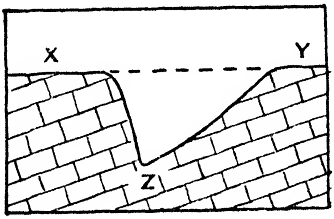

FIG. 12.—REJUVENATION—A NEW VALLEY CUT IN A RE-UPLIFTED PLAIN OF DENUDATION

invigorated and begin the cycle of erosion all over again, with the difference, however, that a stream network is already in being and the work of destruction advances with greater rapidity. In the accompanying Fig. 12, X-Y represents the surface of an old land of tilted strata, which has been planed down to a lowland of denudation and then re-uplifted. Down into the newly raised upland a stream, re-invigorated, is now incising a deep valley, XZY. Many of the land-surfaces of the British Isles are in this condition of being at least in their second cycle of erosion.

PART II

THE SURFACE EXPRESSION OF DENUDATION

SECTION VI

RIVER WORK—THE IMPETUOSITY OF YOUTH

MONMOUTHSHIRE GORGES

A long straight stretch of valley, wall-like mountains upon either hand.

STEVENSON: *Essays of Travel.*

The Map.—Ordnance Survey, England—Scale 1/63,360: Popular Edition, Sheet 102, Newport (Mon.) and District.

The District Selected.—The north-western quarter of the sheet, embraced by the co-ordinates 1–5, A–F, where the rivers are flowing in deep gorges.

General Description.—The first three maps, together with that of the Rhône Delta, form a connected series, illustrating the progressive stages—early, mature, late—in the destruction and reconstruction of land surfaces by the work of rivers. This map illustrates the early stage. It covers parts of Glamorgan and Monmouth. Newport appears near the southern margin; Cardiff lies five miles to the south. Merthyr Tydvil is just off the map to the north-west.

The South Wales coal-field differs from all others in Britain by its mountain character. The structure is that of an oval basin, elongated from west to east and high in altitude. Its preservation is due to the very resistant Pennant Grits, which fill its centre, and to its strong downfolded structure. It is the barren Pennant sands that form the moorlands, some 1500 feet above sea-level.

But the most conspicuous feature of this north-western district is the number of straight streams and narrow valleys, aligned from north-north-west to south-south-east—Ebbw (Ebwy) Fach, Ebbw Fawr, Sirhowy (Sorwy), Rhymney, one unnamed (Western Rhymney) and Bargoed Taff. The streams rise on the northern rim of the basin and flow across its breadth. Their directions, which thus obviously disregard the present arrangement of the strata, are probably consequent on an original slope

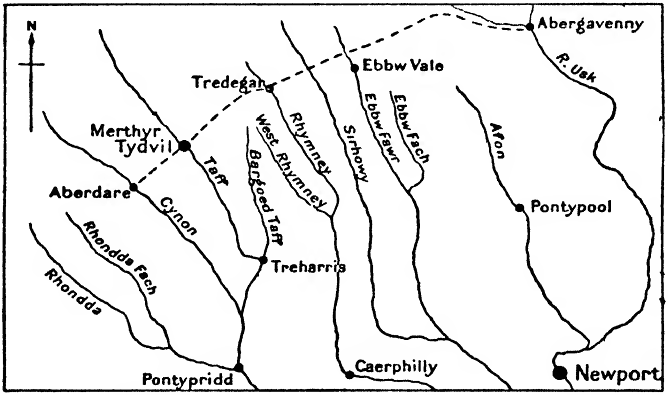

FIG. 13.—SOME RIVERS OF SOUTH WALES

towards the south-south-east, formed by overlying strata which have since been removed. The relief model (Plate IA) should be compared carefully with the map.

Five other river valleys lie to the west and one to the east (Afon) besides the Usk. Of these twelve, four converge on Newport and eight on Cardiff, as named on the accompanying diagram. They all have trenched deeply into the moorlands. It will make for clearness, if the parts are examined in systematic order—lengthwise valley profiles, crosswise valley sections, tributaries and their adjustments to the main rivers, interstream areas.

Valley Profiles.—It will be sufficient to examine one river. For all are digging into rocks of the same nature and structure, all are working with the same water-borne tools, all are much alike in velocity and volume, and all are in the same early stage of their life work. The Ebbw Fawr may serve as a type.

The gradient can be calculated by measuring the spaces between the points where the contour lines cross the river. In this case they are not easy to find, but the 650-foot spot-height, 2 miles above the confluence, is a helpful starting-point. The measurements are approximately as follows :—

Contour spacings.	*Distance.*	*Fall.*
900–800	1 mile.	100 feet per mile.
800–700	1¼ miles.	80 ,, ,,
700–600	1½ miles.	67 ,, ,,
600–500	1¾ miles.	57 ,, ,,
500–400	2 miles.	50 ,, ,,

These figures suggest that the Ebbw has a steep profile and rapid current. The table suggests further that the river is flattening that profile in a normal way, from the mouth upstream. There are no lakes, nor does the map give any indication of falls or rapids, though it seems probable that the river has not yet cut out all the latter at any rate.

Valley Cross-Sections.—By their close succession the contours express the depth to which the rapid rivers have dug, more than 1000 feet below the mountain summits. The valley sides are very steep ; for the contours could hardly be packed closer. The concentrated erosion along the stream bed has outstripped the dispersed weathering on the valley flanks. In many cases the latter plunge directly to the stream ; for there is hardly a sign of a flood-plain, barely room for the necessary roads and railways in this busy region. The cross-section is the gorge

of a mountain valley. The air-view (Plate IB) is taken at Bargoed, where the two Rhymney Valleys meet, and should be compared closely with the map. It shows something of the narrowness and depth of the valleys and the steepness of their sides, which drop almost direct to the streams. The railway runs on artificially cut ledges. The road in the background climbs steeply. The hill-sides can bear only scrubby bushes and stunted trees; the fields look poor; there is hardly a patch of cultivation.

Tributary Streams.—In the case of the two Ebbws the tributaries seem confined to the eastern side, a fact perhaps due to its greater exposure to the westerly rain-bearing winds. They are few, especially in the case of the Ebbw Fawr. In the case of the Ebbw Fach, though more frequent, they are very small; they have not, as yet, even turned the straight lines of the contours. Their gradients are very steep, and their profiles irregular.

The main streams are many and individual; their basins are long and narrow. Capture is not yet much in evidence, though it has just begun. For, while the Ebbw Fawr rises on the northern rim of the coal-bearing basin, the Ebbw Fach, though originally rising as far back, has been beheaded from the east and so rises now three miles further south.

Inter-stream Backs.—The mountain back between the two Ebbws is barely touched by the tributaries. There is no close network of streams covering and destroying the inter-stream areas. Below the junction the tributaries have trenched more deeply and have even developed miniature basins of their own. Their grade, however, is still very steep, twice as steep as that of the main rivers. The larger are bringing their mouths into adjusted junctions instead of plunging down like torrents.

Other Large Scale Illustrations and Atlas Examples.—Gorge-like and V-shaped valleys are characteristic of all

highland regions with rapidly flowing streams. Famous gorges in the upper courses are those of the Yangtse, the Amazon, the Fraser and the Kicking Horse Canyon, the last two of which help to guide the Canadian Pacific through the barrier of the Pacific Cordillera. Similar gorges occur elsewhere in a river's course where streams cross bands of resistant rock: such are the Avon Gorges, first at Bath through the limestone Cotswolds and then through a second transverse limestone band at Clifton (Bristol), or the Goring Gap by which the Thames breaches the Chilterns; similar are the deep, narrow "gates" of the Medway through the North Downs at Maidstone in Section XVII. Similar too are the *cluses* of the Jura and the *poorts* of the Cape Ranges. In a climate that is permanently or seasonally arid the dispersed weathering that opens out valley flanks is reduced, so that gorge-making is encouraged. The famous mile-deep Colorado Canyon in the Painted Desert of Northern Arizona, the gorge of the Tagus at Toledo and that of the Blue Nile and other rivers in the Abyssinian Topland illustrate such cases.

(For the associated human study, see Section XXIII.)

SECTION VII

RIVER WORK—THE SWINGING VIGOUR OF MAN-HOOD

RIBBLE MEANDERS

Bubbleless speed so still that in the hush
One hears mined earth dropping from the bank,
Slipping in little falls whose tingeings drown,
Sunk by the waves for ever pressing on,
Till with a stripping crash the tree goes down,
Its washing branches flounder and are gone.

MASEFIELD: *The River.*

The Map.—Ordnance Survey, England—Scale 1/63,360 : Popular Edition, Sheet 29, Preston.

The District Selected.—The River Ribble and its immediate borders from the east edge of the sheet to Preston.

General Description.—The sheet represents part of West Lancashire. Preston is shown ; part of Blackburn appears on the eastern edge. The Ribble swings in great horseshoe curves across the map. Just off the sheet to the east the heights rise to 2000 feet. In the eastern half the relief is still pronounced ; Longridge Fell (north of the river) is over 1000 feet high, Beacon Hill (south of the river) is over 700 feet. The relief of the western half is of gently swelling undulations under 500 feet, on the surface of glacial deposits laid down during the Ice Age.

The Valley Profile.—The Ribble has sunk its bed rapidly some 400 feet through the soft, glacial cover down to the

solid rock below. The 50-foot and 25-foot contour lines cross the river respectively at Ribble View and close to Preston. These are just over 5 inches apart as the crow flies, or just under 9 inches apart along the windings of the river; in other words, the respective gradients are 1 in 1100 and 1 in 1850. It will be noted how persistently the 50-foot contour follows the sweep of the river for 3 miles from Ribble View to Salmesbury Hall. The profile here is evidently much flatter than the 1 in 50 and 1 in 100 of the Ebbw in South Wales.

The Valley Cross-Section.—With the profile so far advanced here towards base-level, lateral erosion with the lighter tools has been added to downward erosion with the heavier. The former gives the river its characteristic meander belt and its corollary, the construction and widening of a flood-plain. Thirteen or fourteen times over from one side to the other the river swings in vigorous meanders. There is no uncertainty; it is the muscular activity of manhood. At the outer bank of every curve the river current impinges and undercuts a steep concave wall; on the inner side debris is dropped in the slack water to form a protruding alluvial flat. These features are well shown by Plate IIA. The high outer bank, though planted with trees, seems to be slipping. The naked gravel front to the flat tongue shows that it is still growing outwards. So spurs and flat tongues develop, each interlocked with and pointing into a steep-sided concave bank. The valley cross-section becomes unsymmetrical (*a* and *b* in Fig. 14).

Although one such complete spur is still visible near Haugh Wood, where the Ribble enters the map, the work as a whole has advanced beyond this stage. For, as time goes on, the stream impinges on the upstream side of a spur and withdraws from the downstream side (*b*) with the result that the spur is consumed. It is first sharpened (*c*), next reduced to a short cusp (*d*), then worn back to a

blunt salient (*e*), and finally disappears. Meander belt and flood-plain then coincide in width. At Haugh Wood the current is pressing hard into the upstream side of a spur; south of Red Scar there is a shortened pointed cusp; at Elston and Sunderland Hall the spurs are blunted; in other places they have completely gone.

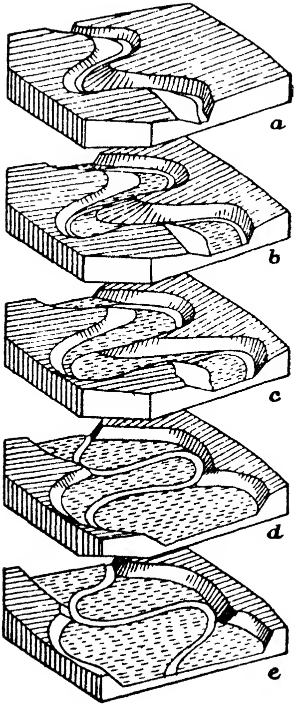

FIG. 14.—THE DESTRUCTION OF SPURS AND THE WIDENING OF A FLOOD-PLAIN

But the meander belt and the flood-plain do not yet coincide in width. The flood-plain is now half a mile wide; the meander belt is nearly double and is still wearing its outer bank at every turn. The concave slopes, often left to woodland, are shown steep by both contour and hachure, notably at Red Scar, Alston Wood and Ramsholme Wood. The banks have been artificially protected at Ribchester; otherwise the church would have been endangered. Half this Roman station has been swept away, and most of the Roman finds in the local museum are due to the lateral excavation of the river.

The valley flanks have a moderate fall, except at concave bends. Hence the steepness and symmetry of cross-section that characterises a young stream, like the Ebbw, has been destroyed, though the uniform gentleness of the late stage has not yet been reached. The valley section has passed from the V-stage to a more open form.

Tributary Adjustment and Inter-stream Areas.—The tributaries are frequent and cover the land; they are of some length and some complexity. The Darwen is a considerable stream. Tributary valleys have sufficiently advanced to be shown by markedly re-entrant contours. They have formed adjusted junctions with main streams; there is no rapid fall, nor is there difficulty in finding the way across the flood-plain. No part of the inter-stream areas is without drainage. Rainfall and land-waste are guided with certainty into the many grooves. Fine in texture, this land-waste will be contributed in ample quantity, but there is no indication that the vigorous Ribble is unable to cope with the load delivered, as is the case with the Trent in the next Section.

Other Large Scale Illustrations and Atlas Examples.—See the end of the next Section.

SECTION VIII

RIVER WORK—THE UNCERTAIN SHUFFLE OF OLD AGE

THE TRENT FLOOD-PLAIN

Where peaceful rivers, soft and slow,
Amid the verdant landscape flow.

ADDISON.

The Map.—Ordnance Survey, England—Scale 1/63,360 : Popular Edition, Sheet 46, The Dukeries.

The District Selected.—The Trent and its borders between Dunham Bridge and Newark—that is, the western half of the Coloured Edition Sheet and the eastern half of the Popular Edition Sheet.

General Description.—The whole district is low ; there is very little of the Trent borders over 200 feet. Although on the Coloured Edition the strength of the hachuring gives a false impression of strong slopes, an examination of the contours and spot-heights soon corrects this mistaken view and indicates a lowland of faint relief. In this stretch of its lower course the Trent is flowing through a mile-wide band of flat alluvium, flanked on either side by extensive deposits of unconsolidated gravels laid down by a greater Trent of bygone days (Fig. 15). It will save time in this study if the reader will run over the names of the villages that border each side of the river.

The Valley Profile.—Not a single contour crosses the river in the twelve-mile reach between Dunham Bridge

and Newark. This suggests at once that the profile has been flattened out. Confirmation is found in the spot-heights. Near Winthorpe 31 is marked and near Dunham

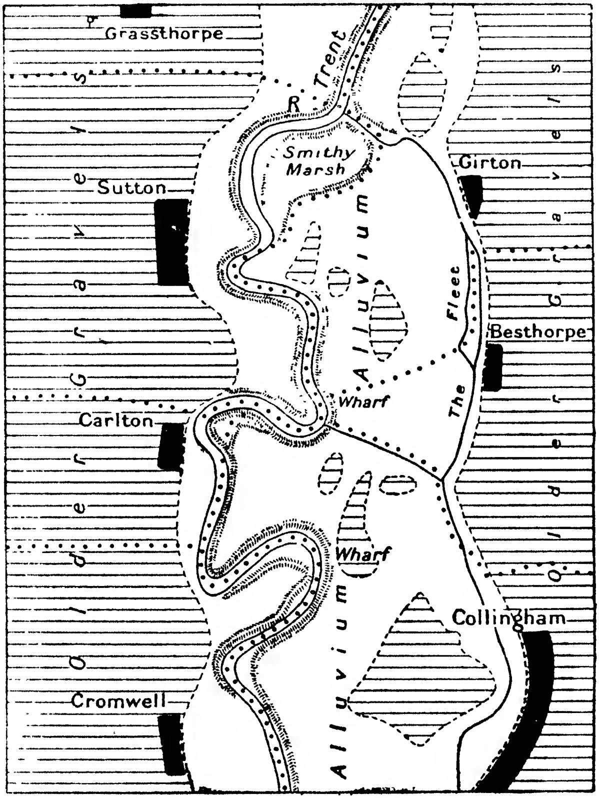

FIG. 15.—THE TRENT FLOOD-PLAIN—GRAVELS, EMBANKMENTS, OLD COURSES AND PARISH BOUNDARIES

(The dotted lines are parish boundaries)

Bridge 18; this represents a fall of 13 feet in 15 miles or 1 in 6000, less than a foot per mile. Compared with the Ebbw (1 in 100) and the Ribble (1 in 1800), the grade is

very gentle; the river is slow-flowing and matches the Lower Thames.

The Valley Cross-Section.—The valley sides are very gentle in slope; indeed on the spot they are hardly discernible to the eye. The valley is wide and shallow. It has passed from the narrow stage of the Ebbw through that of the bowl-like Ribble to the flatness of a plate. Its wetness may be inferred, not only from the many drainage channels, but by the large number of small brooks close to the river. The flatness gives little guidance to these brooks; the two that rise near South Muskham zigzag in quite uncertain fashion. The wetness of the flood-plain prevents tillage; the ditch-divided fields provide rich pasture for the riverside farmer.

Yet the flatness is only apparent, not actual. For the Trent has built up its bed above the level of the surrounding flats, and the alluvial plain slopes away from the river. Several lines of evidence of these reversed slopes are offered by the map.

First, the Trent has been brought under control; it is a tamed river. Embankments (*levées*) line its course, six to ten feet high. But at times it resents restraint and breaks its banks, as do other rivers in the same condition; and, once flooded, the reverse slopes make a return to the normal a slow process.

Secondly, the directions of some of the tributaries indicate the slope away from the river. The one which flows from South Muskham to the west of North Muskham, runs parallel to the Trent for five miles and can only join when a meander brings the main stream right over to the west side of the valley floor.

Thirdly, other streams, draining the flood-plain, rise near the river and flow at first *away* from it; such is the one that rises in a long pool near North Muskham House; another is the small brook that separates Grassthorpe Holme from North Holme, just east of Grassthorpe village.

Fourthly, spot-heights help. Compare Kelham Church, 46 feet, with ½ mile towards Newark, 36 feet; Holme Cross Roads, 30 feet, with ¾ mile east, 26 feet; Meering Ferry, 29 feet, with ¾ mile towards Girton, 24 feet.

The Rambling Meanders of the river are worth studying in some detail. The Trent itself is not straight, like the Monmouth rivers, nor does it swing in bold, vigorous curves like the Ribble. Curves there are, but they seem fewer than they should be, and they seem haphazard, without system. The Trent, in fact, has lost the masculine vigour of manhood; its steps resemble rather the uncertain shuffle of old age.

It is a natural law that meanders migrate (i) outwards, (ii) downstream, as already seen in the case of the Ribble. Smithy Marsh opposite Sutton-on-Trent supplies an excellent example. A bank, ditch and parish boundary (Fig. 15) fix the site of the old Trent. The river has migrated half a mile west and north (outwards and downstream), and the pasture field of 120 acres, though now across the river, still belongs to Sutton parish. The continued migration of the meander is marked by the abandonment of the new bank. The same abandonment of bank is seen in the next loop south of Besthorpe Wharf, and several others can be picked out on the map. The downstream migration is seen, not only in the example, given above, of Smithy Marsh, but in the position of the mouths of the backwaters just above Dunham Bridge and at Sutton-on-Trent. In both cases the river seems to have bifurcated to enclose an island, shown on maps of 1834 (Fig. 16). In each case the meander of the right-hand stream has pushed its way downstream, carrying with it the entry to the left-hand branch, until finally this entry pointed south-west and upstream. The whole flood-plain is, in fact, seamed with depressions representing old channels. Some indication of these may be derived from an inspection on the map of the main road

which leads north-west out of Newark to South Muskham. The hatching along the road marks the positions of a succession of brick arch bridges, where the road crosses such abandoned swampy channels.

A mortlake is clear here. In 1861 this was a well-developed meander. To make operations easier, the railway engineers first built the bridge on the dry land of the neck, then diverted the river along its present course, across the neck and under the bridge. The line was then laid across the deserted bend. Similar artificial shortening

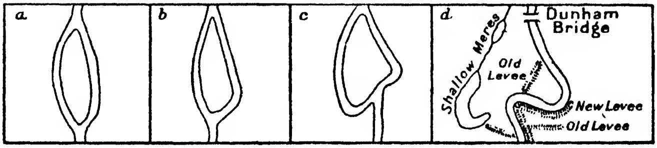

FIG. 16.—THE TRENT FLOOD-PLAIN—MEANDERS AND MEERINGS

has been carried out on the Severn, Danube and other slow-flowing rivers in order to hasten the discharge and so lessen the danger of flooding. Meanders however naturally tend to shorten themselves and leave mortlakes. Often, as already shown, streams rise close to or flow close past the outside of a curve. Should the river break its bank at such a point the flood would be concentrated in a shallow groove and soon scour out the soft, intervening soils. Such a favouring situation seems to occur in North Holme opposite Smithy Marsh as well as elsewhere.

The whole Trent would seem to have migrated westwards by stages across the width of its present alluvial flood-plain. First, on the east of the Trent the earlier gravel sheet has been cut up and reduced to patches, while on the west it remains a solid sheet, as is illustrated in the accompanying diagram (Fig. 15). A second piece of evidence is provided by the map. Along the eastern edge of the flood-plain is marked The Fleet stream. It rises near Newark, runs parallel to the road for ten miles

to South Clifton and here and there widens into elongated sheets of water. One of these near Besthorpe is shown on Plate IIb, and the flatness of the flood-plain is also clear. Four times over this channel sends branches across the flood-plain to join the Trent (Slough Dike, near Besthorpe Wharf, at Girton and at Clifton Hill). The Fleet stream represents an earlier course of the Trent.

The above-mentioned branches must be of ancient date, for the Coloured Edition shows all four to form parish boundaries (see Fig. 15).

Tributary Adjustment and Inter-stream Areas.—None of the larger tributaries are shown on this map; part of the Idle appears to the west and joins the Trent lower down. There is, however, sufficient evidence that hardly a square mile is untouched by streams. The tributaries are sufficiently numerous to ensure a rapid discharge of the rainfall and land-waste, so rapid in fact that the slow-flowing Trent cannot cope with the excess in times of heavy rain or rapid thaw.

The tributaries, too, have graded their channels. The Beck (which joins from the west at Carlton), for instance, is crossed by the 50-foot, 100-foot and 150-foot contours, but there is a distance of 3 miles between each pair, a fall of 50 feet in 3 miles. The valleys are wide, shallow and open, and the tributary streams form adjusted junctions with the main stream—indeed the tributaries have difficulty in entering, as has already been instanced by the stream that flows from South Muskham parallel to the Trent for 5 miles. A big atlas will show that similar difficulties hamper the entries of the Yazoo into the Mississippi for 180 miles and of many tributaries into the Murray for 100 miles and more.

Other Large Scale Illustrations of Meandering Rivers.—The Salisbury Avon, sunk into Salisbury Plain between Upavon and Salisbury, gives instructive examples of

spurs in various stages of ruin. In the Links of Forth below Stirling, the Crooks of Lune above Lancaster, and in the shuffle of the Nene at Oundle, the rivers are staggering in uncertain fashion, like the Trent, across their lowlands and are matched by the "Collywobbles" of the Bashee in the Trans-kei Territories of the Cape Province. The Mersey above Warrington and the Severn at and below Gloucester display loops severed, artificially and otherwise. In Devon the Tamar and the Torridge illustrate deep-sunk, incised meanders and interlocking spurs. But probably the most striking examples are provided by the Wye between Hereford and Chepstow, Ribble-like above Ross, incised below.

Atlas Examples.—It is worth while to turn to a big atlas, like the Times Atlas, and look out the following: the swings of the Seine between Rouen and Havre; the deep-sunk meanders of the Moselle between Trier and Koblentz; the Middle Rhine between Basle and Mannheim for oxbows and the difficulties of entering tributaries; the staggering wobbles, parting channels and cut-off loops (largely artificial) of the Danube and Tisza through the Hungarian Lowland. The Mississippi and the Murray have already been mentioned. Nor should the River Meander (Menderes) in Asia Minor be omitted; for it is the source of the term.

Reference.—For the Trent, see *Geographical Journal*, 1910, *Some Recent Changes in the Course of the Trent* by Bernard Smith. The above notes are largely based on this article through the courtesy of the author. See also a description of the Lower Trent in *Physical Geography for Schools*, 3rd Edn., 1931 (A. & C. Black, Ltd.), pp. 99–101, by the same writer.

(For associated human notes, see Section XXVI, Other Large Scale Illustrations.)

SECTION IX

RIVER WORK—THE MASTER BUILDER

THE RHÔNE DELTA

Miles and miles and miles of desolation,
Leagues on leagues on leagues without a change,
Sign or token of some eldest nation
Here would make the strange land not so strange;
Time forgetting, yet since time's creation,
Seem these borders where the seabirds range.
SWINBURNE: *In the Salt Marshes.*

The Map.—Carte de France, Service Géographique de l'Armée—Scale 1/200,000: Sheet 73, Montpellier.

General Description.—The Mediterranean Coast of France stretches in a long curve from the Pyrenees to the Italian Frontier. Midway the delta flats of the Rhône thrust themselves forward and separate the rocky promontories and pocket embayments of the Maritime Riviera from the coast of Languedoc, once similar but now fringed with a monotonous curve of sand-bar and lagoon.

Delta-building is the consequence of the deposition of river-loads in a tideless sea, the alongshore currents of which are incapable of clearing the mouths. On this sheet the boundary, where old coast and deltaic flats meet, is made clear by the distinction between the contoured, hill-shaded background and the white marginal levels and fens. The heights are given in metres.[1] The new-built deltaic

[1] To convert metres approximately into yards, add one tenth; then reduce to feet for comparison with heights on British maps, *e.g.*, 320 metres = 320 + 32 = 352 yards = 1056 feet.

fringe that fronts the Gulf of Lyons is the constructive work of the Rhône and other streams. It is convenient to consider this composite delta in three divisions :—

The Western Division, from the western edge of the map past Montpellier to Aigues-Mortes.

The Central Division, the Ile de la Camargue, between the branches of the Rhône.

The Eastern Division, La Crau, between the Grand Rhône and the eastern edge of the map.

The Western Division—Sand-bar and Lagoon—is the work of a number of streams of which the largest shown on the sheet are the Vidourles and part of the Hérault. They descend rapidly from the uplands (1000 feet), much of which is limestone garrigue or bare, rocky heath, and from the Cevennes still further back. They have sorted out the land-waste progressively, as they laid it, from heavy to fine and have spread it in fringing terraces and gentle slopes, which form one long continuous vineyard. On the map the presence of many villages testifies to successful vine-cultivation; their absence implies garrigue.

Some of the outer and finer material has been beaten up by storm-waves into off-shore bars, tying Cette to the mainland, as Chesil Bank off the coast of Dorset has tied Portland to Weymouth, and shutting in a line of lagoons or *étangs* (*stagnum*) from the Etang de Thau to the Etang de Maguio. Alongshore currents have smoothed the fronts of these banks into sweeping curves, and onshore winds have added strength to the bars by drifting the sand into a natural breakwater of dunes off the Etang de Thau or a triple barrier off the Etang de Maguio. In the still water behind, the stream-loads are now being dropped —building an ever-growing ragged fringe and shallowing the *étangs*, so that a line (Canal du Rhône) has had to be deepened for barge traffic in the sheltered water between Cette and the Rhône. Eventually the deposits will be converted into dry, fertile land and provide sites for farms

and villages, as already has been done behind (Maguio and others). The name Aigues-Mortes (dead water) suggests the stagnant, unhealthy nature of these lagoons and marshes.

Central Division—Ile de la Camargue.—At Fourques, as the name implies, the Rhône forks into two distributaries, Le Grand and Le Petit. Le Grand is obviously the larger branch, judged both by the name and by the map. Actually it carries 86 per cent. of the water and 99 per cent. of the sediment. The great, swift Alpine river, having gathered its load from right and left all the way from the Lake of Geneva to Arles, toils " like some great veteran dying " through salt-encrusted waste and moving sands, through " the tall marsh-grasses and the reeds and rushes, haunted by the gnat " ; its deposits amount to over 25 million cubic yards of stones, sand and mud each year. So great a quantity would require a train of fifty 10-ton trucks every ten minutes day and night throughout the year. The vigorous work of the Grand Rhône branch is clear from the protruding Ile du Plan du Bourg ; it is said to be pushing out lobes (the *theys* of the map) at a rate of 175 feet per annum, and the menace to the Golfe de Fos is evident. A hundred and fifty years ago a watch tower stood at the coast line ; it is now five miles inland. Borings, 300 feet deep, have not reached bedrock. L'Ile de la Camargue shows much of the initial lagoon already filled up either as marsh or as solid land, reclaimed by human enterprise, though the great, central, " lonesome Vaccarès lagune " and its minor associates remain as a shallow sheet of water of some fifty square miles.

Deposits of alluvium, as was the case with the Lower Trent, raise the beds of the river-branches and form natural banks, often strengthened by artificial means, above the surrounding land. Drainage channels may be seen directed away from the river, of which some are *canaux d'irrigation* in this Mediterranean land of summer

drought, and some are used to keep the soil clear of salts. Yet in spite of embankments and human vigilance disaster comes periodically; streams change their courses. There are few spot-heights on this map by which to check such reversal of slopes. One must look for other evidence.

A case of change of course is indicated by the sharp angle where the Petit Rhône turns at Silvéréal, leaving its abandoned channel along the line of the canal. A further effect of this upbuilding of the stream bed and its reversed slopes is that rain and river water drains and seeps away to the central region between the rivers and retards the filling up of marsh and lagoon. The map illustrates well how settlements, roads and railways are placed along the slightly higher and less sodden ground near the river, whether the Grand or the Petit Rhône.

Eastern Division—La Crau.—La Crau is the work of the River Durance of yesterday, when it flowed at great speed from Alpine heights through the gap at Lamanon (in the north-east corner of the sheet) and spread a sloping, triangular fan between the Grand Rhône and the limestone hills that border the Etang de Berre. La Crau is an immense waste of stones, a Saharan *hammada*, except where irrigation canals and roadways in the north-east and north-west show that men are slowly reclaiming the desert. To all outward appearances a level, in reality it slopes outwards from its apex at Lamanon; spot-heights diminish from the 68 metres at Merle westwards to 42 and 9, southwards to 46 and 10.

La Crau may be taken to represent the completed stage of delta-building in so far as marshes and *étangs* are few; most of the land is dry and solid. The level surface allows movement direct from point to point, by road from Arles to Salon and by rail from Arles to Miramas.

If, then, the map be looked at from west to east, it presents a summary of stages in delta-building from the

sand-bars and lagoons of the west through the marshes of the centre to the solid land of the east.

Other Large Scale Illustrations.—Delta-construction in lakes is illustrated in " A Chapter in Lake History " on the Cumberland Sheet (Section XIX), and in the sheltered heads of fiords like Loch Etive on the Oban Sheet (Section XXXI) and of rias like those of South-Western Ireland (Section XXXII).

Atlas Examples are naturally most frequent in the quieter waters of inland or semi-inland seas of all the continents. The atlas will show the curved form of the Niger and Zambesi Deltas, and of the Ganges-Brahmaputra with its wet jungle of the Sundarbans. The curved delta of the Nile illustrates well the terminal lagoons; Alexandria is built on a lump of limestone and tied, like Cette, to the beach which shuts in Lake Mareotis. While the triple-streamed Danube Delta in the Black Sea is similarly symmetrical in outline, that of the Volga in the Caspian is emphatically lop-sided, due presumably to currents from the north. On the other hand, the deltas of the Po and the Ebro are lobed, but the most striking example of this type is the three-fingered forward delta of the Mississippi.

The Rhine Delta is the classic example of polders reclaimed, drained and watched by a famous corps of water engineers. Its island front is due to an inroad of the sea in 1421. The map of the United States should suggest how the delta of the Colorado has cut off the head of the Gulf of Lower California in the low levels surrounding the Salton Sea. Mesopotamia is the filled-up head of the Persian Gulf, as the Plain of Lombardy is of the Adriatic. The map of China will probably reveal how the Hwang-ho last changed its course from the south to the north of the rocky Shantung Peninsula.

Reference.—A fine series of photographs, with introductory text, in *Les Grandes Régions de la France, Région Méditerranéenne* by de Martonne (Payot, Paris) illustrates the sand-bars, lagoons and other features of the Rhône Delta and its life. See also R. D. Oldham: *The Portolan Maps of the Rhône Delta* (Geographical Journal, 1925).

(For the associated human study, see Section XXVI.)

SECTION X

RIVER WORK—WHERE MIGHT IS RIGHT

THE DISMEMBERED TARF

His youthful hose, well saved, a world too wide
For his shrunk shank; and his big manly voice,
Turning again toward childish treble, pipes
And whistles in his sound.

SHAKESPEARE: *As You Like It.*

The Map.—Ordnance Survey, Scotland—Scale 1/63,630: Coloured Edition, Sheet 64, Kingussie and District. When this is out of print, then Bartholomew's Half-Inch to the Mile Reduced Survey, Scotland: Sheet 16.

The District Selected.—The southern half of the sheet, enclosed by the co-ordinates 1–12, E–J.

General Description.—The rock is the characteristic gneiss and schist of the Scottish Highlands, rising to summits of a uniform height between 2500 and 3000 feet. The whole district bears the impress of an ancient Ice Sheet in the smoothed, rounded outlines of its "unpeopled glens and mountainous retirements." But on the rounded surface left by the ice two forces, frost and post-glacial torrents, have since been working.

The Ancient Tarf Valley.—Across the southern half of this wild and lonely moorland, from Loch Bhrodainn in the west to the Falls of Tarf and Glen Tilt in the east between the two marginal G's of the map, there lies a long valley; its floor is occupied by westward- or eastward-running streams.

This valley is a wide, open hollow, falling gently towards the east all along the line. Its floor is trenched by another deep-sunk valley, or series of valleys, eroded by and therefore falling with the present streams. It can hardly be doubted that the upper, outer valley was formed by one single eastward-flowing river, and that this was the one of which

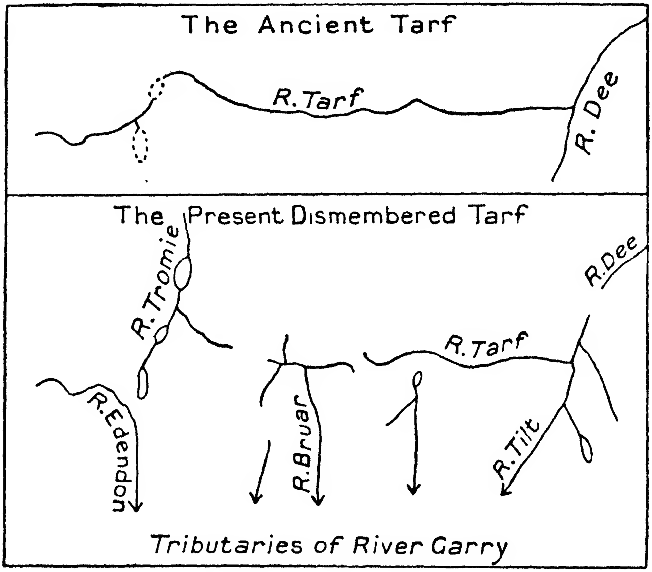

FIG. 17.—RIVER PIRACY

(*a*) THE ANCIENT TARF. (*b*) THE DISMEMBERED TARF

the modern eight miles of the Tarf is a much beheaded remnant. This ancient river (Fig. 17) would seem to have risen to the west-south-west of Loch an Duin (G/H, 3) and, after a course of some 20 miles, to have turned north-east along the northern part of the Glen Tilt fault-valley and joined the Dee (near the D of the east margin of the map). Since that date this ancient Tarf has been dismembered five times over. The story will come out most clearly, if taken

in successive stages. It is one of the clearest and most striking cases of river capture and of the migration of divides in the British Isles.

Dismemberment by Northern Competitors.—The original, long Tarf probably flowed eastwards and joined the Dee, as shown in the figure. It was threatened on its northern flank near its head by the Tromie, tributary to the River Spey, which is fast-flowing (north-eastwards) across the north-west corner of the region.

The rapidly-eroding Spey increased the fall and therefore the power of the Tromie. The latter, sapping rapidly headwards, undercut the Upper Tarf between Loch an t'Seilich and Loch Bhrodainn and so diverted into itself all the Tarf waters gathered west of the line of lochs.

Next an obsequent tributary (one still later developed) of the Tromie—the present Allt Gharb Ghaig—worked headwards and eastwards along the old Tarf valley, capturing in succession three and a half miles of Tarf drainage, that is, as far as the present county boundary. So far, then, the Tarf had been twice robbed.

Dismemberment by Southern Competitors.—A glance at an atlas will show that the southern rival of the Spey is the Garry, a tributary of the Tay. While the predatory Spey was working on the north side, the Garry was not idle to the south. Its fall was twice that of the Spey, so that it was deepening its glen with still greater energy and giving its southward flowing feeders increased power of work. These feeders, the Edendon, Bruar and Tilt are shown on this sheet, flowing to the southern margin near the numbers 3, 6, and 9. They too, like the Tromie but presumably at an even faster rate, sapped and extended their lengths headwards towards the ancient Tarf.

Edendon Water seems to have wrested the extreme headwaters of the old Tarf, south-west of Loch an Duin, from its rival the Tromie.

The Bruar sapped still further headwards. It invaded the main Tarf valley, threw out piratical tributaries east (Allt a' Chuil) and west along this valley. By so doing, it captured and reversed for itself some three miles of tributaries from the Tarf.

The Tilt, similarly, worked rapidly headwards, helped by the weakness of the Glen Tilt fault. It beheaded the Tarf, where the latter turned north-north-east along the fault line. It captured also the An Lochain and the Gleann Mòr Burn from the south-east. Greatly strengthened, it is pushing further headwards along the old Tarf floor towards the Dee, and here, as elsewhere, further captures are threatened.

By means of these captures the Spey on the north and the Tay on the south are extending the boundaries of their basins at the expense of the Dee to the east.

Additional Details.—The Bruar flows southwards. North of Bruar Lodge its valley is wide; south of the Lodge the valley is particularly narrow. The northern section would seem to represent an older valley, tributary to and sloping to the one-time Tarf stream. The southern half is of more recent date; it is the valley of the early southward-flowing Bruar, when it rose south of Bruar Lodge. It worked headwards and invaded the existing northern section, seizing and reversing its drainage.

The unnamed left bank tributary, entering from the south-west, that is, back-set to the present direction, opposite Creag na h-lolair Mhòr, also points to a main valley sloping to the Tarf. Further confirmation is seen in the fact that between the Edendon and the Bruar four streams still flow north to the old Tarf valley and each has its counterpart in a stream flowing south to the Garry; and in each case the advantage of gradient is with the latter. The story of the Bruar looks like being repeated here.

The Mhairc presents a similar story. Between the second and third mile below Loch Mhairc the stream drops more than 500 feet and the valley thereafter is deep and narrow.

Here was the source of the pre-glacial Mhairc. North of this point the valley is wide, open and gently graded. This fact, together with the back-set tributary on the west bank and the channels marked on the map at its head, point to a northward-flowing stream. This back-set tributary itself seems to have been beheaded by the southward-flowing Allt Diridh.

The back-set tributaries of the Tilt, from a mile above Forest Lodge and northwards, indicate this point as the dividing line between the Tilt flowing south into the Allt Mhairc and a stream flowing north into the Tarf and so to the Dee. The Tilt worked headwards along the weak Glen Tilt fault-line, reversed this stream, stole the Tarf on the west and the an Lochain and Gleann Mòr Burn on the south-east from the Dee. This large extra supply of water increased the power of the lengthened Tilt. The river thus outstripped the captured streams in downward erosion. The Tarf, therefore, as the map marks, has still to "fall" into the Tilt. In its efforts to keep pace with the lowering of the main valley, the Tarf has cut a narrow and steadily deepening gorge. This is sunk into the old valley floor for the last two miles of its course and is suggested, not only by the sharply re-entrant contour, but by the steepening of the hachures for half a mile above the falls. A similar gorge is well marked on the map for the last mile and a half of the Gleann Mòr Burn.

Other Large Scale Illustrations.—On this same sheet the River Feshie has a conspicuous elbow (E, 9); and the Upper Feshie Valley heads directly for and leads easily into that of the Geldie Burn. The map makes it look as if the Lower Feshie had beheaded the Geldie at this point, and, if so, it may be that the apparently staggering steps of the Geldie across part of its valley represent the weakened power of the beheaded burn. But the writer of the article mentioned below states that in the field the case presents many puzzling features.

Other examples of the development of river systems through this piratical habit of streams are given in Part III under Jura-pattern Drainage (Southern Ireland, Section XVI) and Wealden-pattern Drainage (Maidstone District, Section XVII).

On the Lake District Sheet, Raise Beck, flowing from Helvellyn, has been captured from a stream flowing to Thirlmere by the one flowing to Grasmere, which is 300 feet lower. On the Newport Sheet the Bargoed Taff seems to have been captured by the Taff at Treharris (E, 1).

Atlas Examples.—A good atlas should show another excellent Scottish example of capture to the north-east of the Cairngorms, just off the Kingussie Sheet, where the eastward-flowing Don has been beheaded by the Spey-ward Avon. In England many individual eastward-flowing Pennine rivers, still represented by the Tyne and Tees to-day, seem to have been beheaded and diverted by the Yorkshire Ouse, as it lengthened its way headwards along the Vale of York. The Trent at Newark seems to have turned the Upper Trent away from the Witham, to the gap of which at Lincoln the direction of the Upper Trent points. In Devon a tertiary river perhaps began with the south-eastward-flowing Upper Torridge and continued past Exeter and through the Vale of Taunton into the Tone and Parret in Somerset. It seems to have been dismembered by the Exe from the south and the Torridge from the north, from which the latter derives a hook pattern, comparable with the Upper Feshie. In Wales the Upper Usk seems originally to have joined the Wye along the Vale of Brecon on the west of Black Mountain but to have been tapped by the Lower Usk, which now separates Black Mountain from the Brecon Beacons.

In Europe the narrowness of the basin of the Meuse seems to be due to the fact that it has been robbed of tributaries by its stronger neighbours, the Seine and the

Moselle; for instance, the Moselle at Toul seems to have diverted what was once the Upper Meuse; the old valley, now a dry wind-gap, is followed by the Paris-Nancy-Strassburg railway.

Other atlas examples are given in Sections XVI (Jura-pattern Drainage) and XVII (Wealden-pattern Drainage).

Reference.—Alexander Bremner, D.Sc., *A Geographical Study of the High Plateau of the South-eastern Highlands* (*Scottish Geographical Magazine*, 1919). This Section is based directly on part of the above-mentioned article by the courtesy of the author.

SECTION XI

ICE WORK—THE ICE-SHEET

ROCK AND TARN IN THE OUTER ISLES

> The surface of Scotland, like that of Ireland and the northern half of England, as well as the whole of Scandinavia and Northern Europe, is distinguished from southern countries by a peculiar contour, visible almost everywhere, irrespective of the nature of the rock. This contour consists in a rounding and smoothing of the hills and valleys into long flowing outlines.
>
> GEIKIE: *The Scenery of Scotland.*

The Map.—Ordnance Survey, Scotland—Scale 1/126,720: Sheet 10, North Uist.

The District Selected.—North Uist.

General Description.—North Uist and Benbecula are parts of the great breakwater of the Outer Hebrides. Long Island, the alternative name for the whole group, suggests that they rise as a bank from the deep waters of the Minch; the map shows that at low tide not water but five miles of rock, sand and mud join North Uist to Benbecula. Indeed, the tracks across the sands of South Ford are clearly marked.

This sheet and the next illustrate the details of relief as moulded by ice. Distinction must be drawn between the work of ice-sheets, like those which cover Greenland and Antarctica to-day, and that of valley-glaciers, dying remnants of the Ice Age, which have shrunk to high altitudes in the mountain ranges of the world. The former move across country like a flood, regardless of inequalities

of surface, and, when they have disappeared with the advent of warmer conditions, leave a legacy of smoothed and rounded outlines. The latter move down the valleys, streams of ice, and modify local valley detail only.

The Legacy of the Ice-Sheet in North Uist.—The rock of which the island is built, some of the oldest in the world, is Lewisian gneiss. The map indicates a lumpy lowland of boss and hollow. But by far the most conspicuous feature is the intricate maze of ragged sea-inlets and rock-tarns without number, covering almost as large an area as the bare grey stone itself. And, looking at the map, we may envisage them as ragged in outline, shallow in depth, clear to their rocky bottoms and studded with numerous, round-backed islets. In spite of the complex ramifications, dominant direction lines from south-east to north-west seem traceable out of the welter of channels and peninsulas which run inland from Loch Maddy, Loch Eport and other lochs.

The ice-sheet approached from a south-easterly direction. It scooped long, shallow hollows and smoothed the low ridges into elongated bosses. It stripped bare the rocks and summits in its course, pushed and ground the debris beneath its weight and left behind a mantle of hummocky morainic rubble along its outermost margins. Some of this debris perhaps has been beaten up by westerly gales and breakers into the dunes which patch the Atlantic coast.

The resulting scenery is one of desolation. Monotonous whalebacks of bare, grey stone—morass and peat and water—not a tree or a bush higher than heather. "Peat and water and rock, rock and water and peat—that is North Uist," and the water adds midges "beyond measure bloodthirsty." The photograph on Plate IIIA illustrates these features. The view is taken from Ronay, looking north-north-west, and shows intricate channels and lochs as well as the smoothed outlines of Ben Eaval, of the two

Beinns on the near side of it and of the lower peninsulas and islands. The round outlines of South Lee are in the distance. Nearly every detail can be traced on the map.

The islanders are as poor as the land. A few fisher-gardeners along the straggling arms that reach into the heart of the island or along the western seaboard eke out a bare subsistence by enriching small pockets of stubborn soil with kelp collected from the shores—that is all.

Atlas Examples.—Similar scenery, but on a larger scale and more generous in what it offers, will be found by looking in the Times Atlas at the glaciated, crystalline Laurentian lowland of the Canadian Shield which lies round Hudson Bay between the Polar Seas and the Great Lakes and the St. Lawrence. It is matched in Europe by the similar lands of the Baltic Shield that surrounds the Gulf of Bothnia, in Sweden and Finland. Their intricate network of rivers and rapids, like the Imatra and its Falls, and their myriads of ragged, island-studded lakes, like Lake Saima, are apparent.

SECTION XII

ICE WORK—THE VALLEY GLACIER

GRAMPIAN GLENS AND CORRIES

The glaciers creep,
Like snakes that watch their prey, from their far fountains,
Slow rolling on.

SHELLEY: *Mont Blanc.*

The Map.—As for Section X, Kingussie and District.

The District Selected.—The northern half of the sheet, especially Glens Feshie and Tromie, and the Cairngorm Mountains. There is also a "Tourist" Edition, the Cairngorms, but it does not include the Tarf (Section X).

General Description.—The rock is mostly the characteristic gneiss and schist of the Scottish Highlands, forming wild glens and moorlands, though rarely over 3000 feet. The north-east quarter of the sheet, however, is mainly of granite, which rises to over 4000 feet in the Cairngorms. Granite presents considerable differences of scenery; now it extends over miles in tame, level-topped moors, roughened only by craggy tors; now it is gashed by corries and over-deepened glens, savage and inaccessible. Both these types of scenery may be read from the map in the Cairngorm area.

The whole surface, represented by the map, displays the rounding and smoothing of an ancient ice-sheet (except where frost-splintering and river erosion have modified it in post-glacial times). On this is superposed the local

work of valley-glaciers, to which attention is directed in the study of this sheet.

The Valley Profile.—Erosion by an ice-stream or valley-glacier produces results that differ from those of river erosion. In the first place, ice erosion complicates rather than simplifies the valley profile. Instead of the progressive flattening out that comes from the work of rivers, a glaciated valley is broken-bedded; it is apt to show a chain of narrows and basins, ups and downs, lips and hollows, level reaches and steps. Terminal moraines, left by the shrinking glacier, sometimes form barriers across the valley. And lakes, trapped in the basins or dammed back by moraines, are frequent. Some of these features are shown by most of the larger valleys and can be seen if Upper Glens Tromie and Feshie be followed down.

The Valley Cross-Section.—Like a river, a glacier deepens its valley, but the cross-section assumes a U instead of a V form. Tributary valleys lose contact with the more rapidly deepening floor of the main valley beneath the glacier, so that, when the glacier finally disappears, tributaries "overhang."[1]

Unlike a river, a glacier simplifies its valley flanks. Existing spurs are rasped back into flattened stumps; curves are straightened out. Many of the above features can be illustrated from this sheet.

The over-deepened U-shape is visible in all the valleys, into the flattish floors of which the present post-glacial rivers are now working; such are Glens Truim, Tromie and Feshie. Loch an t'Seilich is over half a mile wide. Its greatest depth is 100 feet or less. Naked rock is

[1] Another theory ascribes the over-deepening to the work of rivers during milder inter-glacial periods and assumes that the main valley was free of ice, while the higher flanks were still covered and so protected from erosion.

visible in part of its floor. Combine these facts with the close lateral contours and the spot-height 1463 at the head of the flat deltaic land that now separates the two lochs, and the suggestion is a straight-sided, high-walled, round-bottomed glen. The illustration on Plate IIIB is taken at Marble Lodge (just off the map), looking north-east along Glen Tilt (J, 9), and shows the rounded form. A tributary valley overhangs on the right (marked but not named on the map) about the right-centre of the photograph.

Tributary Valleys and Inter-stream Areas show features different from regions dissected by rivers alone.

The hanging valleys of tributaries are everywhere. Upper Glen Feshie slopes eastward, wide and open. It turns abruptly at the county boundary and flows for five or six miles slightly north of west. Here contours and hachures show that the glen is narrow and steep-sided. It has been deepened—over-deepened—by the old, local valley glacier, so that, when the glacier finally melted away, the mouths of tributary valleys opened into it high above, that is, overhung it. The nine north bank burns marked on the map, in the four miles between and including the junction of the Eidart and Creag na Gaibhre, plunge abruptly over falls into the main valley, gashing the valley flanks and, though not shown on the map, building fans of debris on the valley floor. The sides of the valley show also many truncated spurs. Post-glacial effort by tributaries to grade their junctions from abrupt to adjusted are visible on the map in the long sloping trench cut by the Allt Lorgaidh in the last mile and a half of its course.

Overflow valleys are another characteristic in which glaciated valleys differ from those that are only river eroded. They are caused by overflow ice thrown off by the main glacier. The most interesting feature of the lower course of the Feshie is the long, narrow gully on the

right bank north by east of Achlean—between Creag Leathen and Carn Ran Beag and extending to and beyond Loch Ghiubhsachan. It carried and was trenched by an overflow ice-stream from the Feshie valley-glacier, when the mouth was obstructed by the ice in Strathspey; it was further scoured out by water. Lateral moraines on the ground indicate its connection with Glen Feshie.

A similar and clearer distributary ice-stream ravine relieved the obstructed Truim valley-glacier between Loch Etteridge (C, 2) and Ruthven (A, 4), a line now occupied by the Millton Burn. Such "through" valleys are numerous—see for example the north-west corner of the map just south-east of Creag na h-lolair.

Corries.—The Cairngorm Massif has what must be the finest series of corries in the British Isles. They face mainly north and east.

The Cairn Toul group is typical. Loch Uaine (lying at

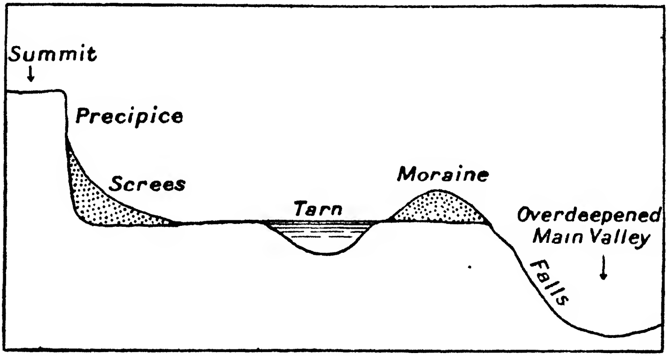

FIG. 18.—SECTION OF A CORRIE

3200 feet) occupies an arm-chair hollow. Above, that is south-west, the back of the chair is shown by the close-set contours to rise steeply for more than 750 feet, until it ends in a precipitous wall to the summit of the mountain. Below the ledge on which the lochain is placed, three

contours lie close together, a steep drop of over 500 feet, over which the escaping water plunges headlong. Here, then, are illustrated the characteristics of a corrie—a bench surrounded by a crescentic wall, which is precipice above and steep talus below; a tarn lies in a rock basin and is drained by a plunging stream. The tarn is often dammed by a moraine, the terminal of a small expiring glacier, the final stage of glaciation. It may be noted that snow often lies all the year round in some of these north-facing hollows; no great reduction of temperature would be required to restore glacial conditions in some, at any rate, of the corries. The corrie next to the south, Coire an Saighdeit, has lost its tarn through deposition, and the stream now starts below the platform.

Other tarn-filled or tarnless corries form the northern face of Braeriach. The walls of the corries at the head of Glen Einich are being broken down by several high-rising streams. A waterfall is marked and the intervening walls between two adjacent corries are being thinned and broken from both sides and therefore tend to become knife-edges. These may be seen, too, on both Braeriach and Cairn Toul.

Moraines of all kinds abound. Lateral moraines form ledges along the valley sides, *e.g.* along Glen Feshie, and are often the only cultivable land in the district. Crescentic terminal moraines are also present. But neither are of sufficient relief to be indicated even by the hachures. In one case, however—in Loch Loch in the south-east corner of the map—two crescentic terminal moraines of a retreating valley-glacier divide the loch into three sections. The upper of the two protrudes from one side, the lower from both. This latter forms an obstruction that causes a drop in the lower lake level from which a boat cannot pass.

Other Large Scale Illustrations.—Among the other sheets used the Lake District has many examples of ice work, as is described in Section XIX.

The Oban Sheet (Section XXXI) also has many examples. The glens are U-shaped and over-deepened. The valley in which Allt Cruachan lies overhangs the Pass of Brander, and, after a relatively gentle course, drops over the edge in the Falls of Cruachan. The Allt Cruachan rises in a corrie, but the tarn has been filled up and converted into a swampy, spongy floor. Examples of " overflow " valleys are numerous. The axis of Loch Awe lies north-east to south-west, and one would expect it to drain from the southern end. That this was once the case in pre-glacial days, is indicated by the lake beaches at levels higher than the present lake and by the traces of such an outlet below Ford. At the time of the Ice Age three valley-glaciers, which came down from Glens Strae, Orchy and Lochy, converged on the head of the glen in which Loch Awe lies. There must have been a tremendous jamming, thickness and pressure of ice down the head of Loch Awe, with the result that an overflow lobe was thrown out north-westward, over-deepening the line of fracture towards Bonawe, while the main body of ice passed down Loch Awe. Thus this overflow tongue eroded a " through valley," a process to be seen to-day among the glaciers of the Alaskan and Greenland coasts. As the valley-glaciers melted back, glacial debris and moundy moraines in large quantities blocked the southern outlet, so that the water of Loch Awe was ponded back till it escaped at the upper end along this overflow valley, the narrow, steep-walled, over-deepened Pass of Brander. A similar relief overflow on a small scale occurred three miles higher up and has formed the overflow valley indicated by the contours and occupied by the Allt Mhoille and Glen Noe. Others can be picked out on the map. It will be noted that they often carry railway and roadway, such as that to Oban through the Pass of Brander.

Many examples of ice-work are conspicuously delineated on the Tourist Editions of the Snowdon and Killarney Districts.

Atlas Examples.—Most of Northern Europe and northern North America retains the effects of glaciation—but, except in high latitudes like Greenland where glaciers reach the sea and calve the icebergs which infest trans-Atlantic routes in early summer, valley glaciers have shrunk upwards to high levels. All the high mountain ranges of the world have valley-glaciers and their characteristics. Perhaps the most studied glacier is the Mer de Glace on the northern slopes of Mont Blanc, near Chamonix. This and others are probably shown on the map of the Alps. Famous glaciers elsewhere are the Malaspina in Alaska and the Tasman in the New Zealand Alps. In the Pyrenees is the famous cirque (corrie) of Gavarnie. The southernmost glacier in Europe is on Mount Mulahacen (11,660 feet) in Granada. Mount Kenya (17,000 feet) under the equator, carries several.

Reference.—M. I. Newbigin: *Ordnance Survey Maps; their Meaning and Use*, chapter v (*The Western Grampians*) (Johnston).

SECTION XIII

WIND WORK—DUNE, BENT AND PINEWOOD

A NAIRNSHIRE SAHARA

The Sea-Wood of Graden had been planted to shelter the cultivated fields behind, and check the encroachments of the blowing sand. As you advanced into it from coastward, elders were succeeded by other hardy shrubs; but the timber was all stunted and bushy; it led a life of conflict.

R. L. STEVENSON : *The Pavilion on the Links.*

The Map.—Ordnance Survey, Scotland—Scale 1/63,360 : Popular Edition, Sheet 28, Nairn and Cromarty.

The District Selected.—The south coast of the Moray Firth between Nairn and Findhorn.

General Description.—Wind-borne dust, water-borne particles and ice-driven grit play a large part in fretting the rocks. The first-named is, of course, particularly vigorous in arid regions, like Arabia and the Sahara, where the effect of the sand-blast is widely evident. But in moist countries, such as Britain, its destructive results are less visible and certainly cannot be illustrated from map-sheets. Along many parts of the coast, however, wide stretches of sand, beaten up by storm waves, laid bare by receding tides and dried on the surface, become the prey of prevailing onshore winds on exposed coasts. The constructive work of the wind is then conspicuous in the profusion of dunes and hollows that line the sea. The Culbin Sandhills (along the southern shores of the Moray Firth) form such a region.

The Invasion.—In the seventeenth century the surface, which on the map is covered by the names Low Wood, Culbin Sandhills and Findhorn Bay, was clothed with rich corn-bearing fields, much like the rest of the land to-day; it had a mansion surrounded by orchards, lawns and gardens with sixteen prosperous farms and was known as the "granary of Moray."

In 1694 the sands of the sea-margin, stirred by strong gales, suddenly began to move from the west, like a devastating flood. In their eastward rush they overwhelmed mansion, orchards, farms and fishermen's cottages. Green fields were buried under white sands; only one farm escaped, Earnhill. In three days—so tradition has it—the old barony of Moray in the Carse of Culbin was submerged. The Laird of Culbin was ruined. In the next year the Scots Parliament granted relief from land-tax and forbade "for all time the pulling of bent, juniper, or broom, to which cause the sand-drift is expressly attributed." The Act is still in force and applies to all—owner, tenant, visitor or stranger.

For a hundred years there was only spasmodic activity in the unstable dunes, but in 1798 pronounced movement began again. The sands pushed steadily eastwards. The submerged mansion became uncovered; blasted apple-trees appeared; remains of contraband cargoes—brandy, wine, tobacco and silks—were revealed. The advancing flood threw a large barrier across the river and ponded back the water into a wide lake, which overflowed and drowned the town of Findhorn, then on the west bank. The stippling on the map makes this clear.

The Sands To-day may be pictured as an array of ridges and hollows, not dumped haphazard but ranged in bands, roughly parallel to the shore of the firth. Such orderly design is suggested on the map by the fourfold succession of elongated ring contours for the sand-ridges that rise apparently to nearly a hundred feet (spot-height 99).

They lie at right angles to the direction of the winds which marshalled them. They show an unsymmetrical form: a long, gentle, upward slope on the windward side leads to a steep drop to lee. Up the former the sand grains are driven to fall and whirl beyond the crest in the eddies beneath the still ascending air. Although it would be unjust, perhaps, to describe the scene as one of " starved, ignoble nature " where nothing throve but patchy grasses which " grew as scant as hair in leprosy," yet the whole is a sand-heap over which a death-like silence broods.

The piles of sand shut in pools and marshes, like Buckie Loch on the north-east and Loch Loy on the south-west of Low Wood; these and the Bar, a bank of hard-packed gravel, sand, and marsh plants, are the haunts and breeding-places of numerous sea-birds. On the east the River Findhorn, pushed eastwards by the encroaching sands, seems to thread its way in braided channels; sands and shingle

> hem his watery march, and dam his streams
> And split his currents.

While still a menace, the landward movement has been stayed by the planting of bents and then of fir and birch (Low Wood); and the eastern prong-like extensions on this map suggest that afforestation is still in active progress, bents first, and then trees when the sand is bound. By skilful planting the owner of Binsness, near the eastern edge of the Wood, has transformed a sand-desert into a park and garden, and the fight against the sand is never relaxed.

On the extreme west of Low Wood are tracts that were never planted, and here the sand is on the move. The map shows one stippled tract where the sand has already invaded and smothered the wood; of this two illustrations are given, the menace in front and the ruin behind (Plate IV). Trees may be seen in all stages of absorption along the front of the advancing surge, while in its rear

scraggy trunks, bleached and lifeless, mottle the "stubbed ground, once a wood."

The present village of Findhorn does not present the life and activity of its forerunner, when the meat and salmon and malt of Moray were exchanged in Rotterdam and Bordeaux for wines, silks, tobacco, and nutmegs. It retains only its salmon-fishing and its mussel-beds, and has a certain popularity as a summer resort.

Other Large Scale Illustrations.—Other illustrations will be found in Braunton Burrows on the Barnstaple Sheet, on the exposed western coasts of the North Uist and the West Lancashire Sheets, on the Rhône Delta and in the western half of the Vesuvius Sheet.

Atlas Examples.—One turns naturally to the Hot Deserts of the World. In Central Asia are "the buried cities of Khotan"; in the Trans-Caspian Deserts Kizil Kum is Turki for Red Sands and Kara Kum for Black Sands; the North Persian Deserts (the Kevirs) are compounded of sand waste and salt swamp. In Arabia the oasis-streaked rock-desert of the central Nejd is flanked north and south by the sterile solitudes of the sandy Syrian and Dehna Deserts; in the Sahara the oasis-girt lumps of Ahaggar, Air and Tibesti are isolated by the sandy wildernesses of the Erg and the Libyan Deserts, where only continuous removal of sand preserves some oases. In Central Australia "sandridge and spinifex" speak for themselves. The arrest of the sand by the planting of bents and pines in the Landes of South-western France is well known.

Reference.—G. Bain: *The River Findhorn* (Nairnshire Telegraph).

PART III

THE SURFACE EXPRESSION OF STRUCTURE

SECTION XIV

LOWLANDS—A COAT OF MANY COLOURS

LINCOLNSHIRE DIVERSITY

The little village of Grand Pré
Lay in a fruitful valley. Vast meadows stretched to the eastward
Giving the valley its name and pasture to flocks without number.
Dikes, that the hands of the farmers had raised with labour incessant,
Shut out the turbulent tides.

LONGFELLOW : *Evangeline.*

The Map.—Ordnance Survey, England—Scale 1/63,360 : Popular Edition, Sheet 47, Lincoln.

The District Selected.—The western two-thirds of the sheet, embraced by the co-ordinates A–J, 1–9.

General Description.—Generally speaking, the district is a lowland of faint but varied relief, and one of varied soils. Two features are conspicuous. North and south past Lincoln four contour lines, 50 to 200, run across the sheet and reveal a low escarpment ; Lincoln is at the Witham Gap through it. From the east a wedge of fen along the river heads for the city. The geological diagram should enable the student to see the varied soils on the map ; the railway lines east of Lincoln are inserted as a guide.

A Lowland of Deposition—Fen Flats.—The Fens are fully developed only off the map to the south-east, but the beginnings of the Fens appear in the white triangle along the Witham, with apex at Lincoln and extension to the

south-east. Built of fluvial and marine sediments, as well as of decayed vegetation in the form of peat, Fenland lies a dead level; contours and hachures are absent. The spot-heights, never far from 10 feet, not only confirm this, but indicate that the lowland is close to sea-level. Here and there only a gravel " island " rises dry above the marsh-

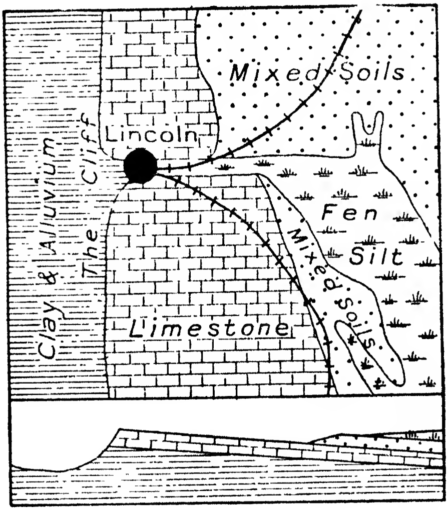

FIG. 19.—THE LINCOLN DISTRICT—GEOLOGICAL PLAN AND SECTION

land, like the famous " Isle " of Ely elsewhere. Bardney (ey means island) (E, 9) seems built on the slope of such a rise. Through this lowland the Witham makes sluggish progress.

Two dangers threaten, floods from the river and heavy rain on the flats. The map shows how human endeavour has faced the menacing situation. To counter the first danger, the Witham, like other fen rivers, is disciplined between artificial embankments as shown, all carefully watched in times of danger. Further, the discharge of the river is eased by the straightening of the loop round

Branston Island and other bends. To remove the second an elaborate system of drainage has been built, and for this purpose in its initial stages Dutch engineers were called in ; it is noteworthy that one of the three divisions of Lincolnshire is called Holland. Subsidiary drains gather the dispersed rainfall and deliver it to main drains, here called delphs (elsewhere called Drains or Levels, *e.g.* the Twenty-foot Drain, the Fifteen-foot Drain, the Bedford Level) at right-angles. The main drains discharge into the Witham through sluice-gates, as at the end of Branston Delph on the map. The sluices are opened when the water-level in the drain is above the river and are closed when the river rises higher than the drain. Frequently the drains are built at rising levels towards the river, and the water is lifted from lower to higher by steam or windmill-like pumps. Fierce opposition to drainage schemes was once encountered, for they removed a profitable means of livelihood by wild-fowling and reed-cutting for thatching. The latter industry is still existent in the Broads of Norfolk. Little true fen now remains ; most has been converted into fertile farms. Wicken Fen, near Cambridge, however, is still preserved in its natural state and its remoteness is suggested by the only dwelling near-by, the " Four Miles from Anywhere " Inn.

A Lowland of Denudation—Ribbed Pattern.—The western half of the map north and south of Lincoln is covered with contours and hachures, though nowhere rising above 300 feet. It is the floor of an old sea basin, carpeted in the secondary era with debris of terrigenous and organic origin ; there was added at a later date, in parts, a mantle of glacial boulder clays. Never of great height, its general level has to some extent been reduced, and its manifold details have been brought into existence by river work and by chemical solution. The lowland is therefore one of diversified relief and varied soils.

This part of the plain of south-eastern England, then, is

built of different rocks, resistant and weak, porous and impervious, warm and cold; they outcrop in regular north-south bands. The diagram and section will help to distinguish these on the map. The dip of the rocks is about half a degree eastwards.

The geological bands are reflected in the systematic division of the surface relief. First, to the west of Lincoln, the lowland consists of weak, impervious, cold clays together with the alluvial strip laid down by the Upper Witham. Its unconsolidated rocks have led to a faint relief, carved out and now drained by the Upper Witham—once covered with woodlands, of which only patches remain, as the map shows, west of the city; the district to-day is chiefly hedge-lined meadows. In some of the parishes the name "Low Fields" is suggestive of these features.

The scarped ridge, which runs north to south past Lincoln, is locally called "The Cliff"; although only 100 to 150 feet high, it is easy to trace, for two or three close contours show its westward-facing scarp. The lime-stone of which it is built is called Lower Oolite or egg-stone, similar to that which forms the Cotswolds. The rock is relatively resistant and hence stands out as a low ridge—porous, water-bearing, and warm—whose eastern side is a gently sloping upland, "The Heath" of the map, furrowed with dry shallow bottoms. Once desolate waste, it was narrowed down by cultivation under the urgent need for food during the Napoleonic Wars and now consists of cultivated fields divided by dry stone walls. Dunston Pillar, near the sixth milestone south-south-east of Lincoln, a beacon to guide belated wayfarers on the once wide heath, was last lighted in 1807. The ridge is breached by the Witham in the gap at Lincoln.

A blanket of mixed soils, formed from the Upper and Middle Oolite and from glacial debris, covers the lower slopes of the Lincolnshire Limestone, to the east of the railway on the south side of the Witham, but overlapping to the west of the railway on the north side; the diagram

will help to identify them on the map. The mixed soils are covered with much woodland, and this adjoins the fenland described above.

Other Large Scale Illustrations and Atlas Examples.—Lowlands of Deposition are relatively small. The Manitoban Prairies and the Hungarian Pussta are the beds of ancient lakes, like the Rosthwaite Basin of the Lake District (see p. 129). Alluvial flood-plains and deltas have already been studied in the Sections on the Trent (Section VIII); other examples are there given. Russian Turkestan is the bed of the shrinking Caspian and Aral Seas, as the Romanian Steppe is the dried floor of an old gulf. Other lowlands may be covered with blankets of soil, laid down in part, at any rate, by wind; such are the loess regions of Southern Russia and the sandy Erg of the Sahara. Boulder clay and moraines, laid down by ice, mantle parts of the surface of the North European Lowland and northern North America.

Lowlands of Denudation are generally large. They are often composed of old, low-lying, horizontal strata which have been etched out into faint but diversified relief, as with Lincolnshire. Such lowlands on the grand scale compose the Central United States and Russia. Different characteristics mark those crystalline lowlands which have been glaciated; the smoothed, rounded rock surfaces and ragged tarns of North Uist give the example taken here (Section XI), and other examples will be found under that section. In general, lowlands of denudation show variegated patterns; the North European Lowland, for instance, which extends from the North Sea to Russia, has a seaward fringe of sand-dune, sand-bar, lagoon and marsh, within which are sea mud, river alluvium, glacial deposits and wind-blown soils, lying on denuded surfaces.

(For associated human notes, see Section XXVI, Other Large Scale Illustrations.)

SECTION XV

HORIZONTAL FORMS—TABLES AND TERRACES: LIMESTONE

INGLEBOROUGH AND GRETADALE

Bleak roads I love without a tree
Or hedge or bush on either side;
No softly coloured scenery,
Only a bare-backed countryside,
Hard ribbed as any skeleton
Of its corruption emptied, dry,
Washed by the wind, bleached by the sun,
A land whose window is the sky.

THOMAS: *Now at Eve.*

The Map.—Ordnance Survey, England—Scale 1/63,360 Popular Edition, Sheet 20, Kirkby Lonsdale and Hawes.

The District Selected.—The centre of the southern half of the map, embraced by the co-ordinates F–J, 6–9. (On the Coloured Edition, the south-western quarter of the map.)

General Description.—The District comprises three regions of different relief. First, the south-west corner is shown as a piece of lowland, 500 feet above sea-level, containing the Ingleton coal-field and village. Secondly, north-east of this lowland and bounding it the scarp of the Craven Fault rises steeply for about 750 feet; the contours show the angle of slope to be about 5 degrees or a rise of 1 in 12. Thirdly, covering the rest of the district, a platform is indicated by the wide-spaced contours, about

1250 feet above sea-level; it is composed of Great Scar[1] Limestone, 600 feet thick. From this platform rise boldly for a further 1000 feet a number of isolated table-topped blocks, like Ingleborough and Whernside; sunk down into and even through this Great Scar Limestone Platform are steep-sided dales, like Kingsdale, Gretadale, and Ribblesdale. The accompanying plan and sections will make these details clear.

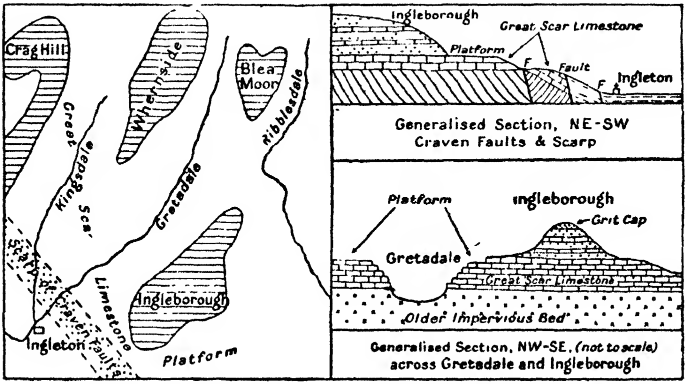

FIG. 20.—THE INGLEBOROUGH DISTRICT—GEOLOGICAL PLAN AND SECTIONS

The characteristic feature lines are horizontal as a result of the stratification, and vertical as a result of the joints. The sharpness of transition is unsoftened over much of the bare Great Scar Limestone, but is toned down elsewhere not only by weathering and grass-covered scree but by glacial deposits.

Table Mountains.—The ultimate form of the relief is the

[1] The following are the meanings of some of the names on the map:—*carr*, a rock; *fell*, a place that falls away steeply, a hill; *force*, a waterfall; *moor*, dry, heather-covered hills; *moss*, wet and spongy with peat and cotton grass; *rigg*, ridge; *scale*, hill with steep ascent; *scar*, bare cliff; *sleights*, smooth slopes; *strid*, narrow channel with rushing water between level rocks.

result of three interwoven factors: (1) the structure and composition of the rocks—here horizontally bedded limestones, with weak shales and hard grits interbedded, (2) the denuding processes—here streams and groundwater, (3) the stage in the cycle of erosion—here early.

At birth the relief is the expression of the underlying structure. Smooth-backed areas, whether low plain or high table-land, result from horizontal stratification. If here the valleys were filled up, such a table-land, lifted 2000 feet, would represent the initial form; the spot-heights on the fell tops show this. The horizontal stratification of table-lands and platform is confirmed by the coincidence or parallelism of scar and contour on Ravenscar, Twistleton and other scars; or, more correctly, the acute angle at the points of intersection of scar and contour indicate a slight dip north-north-east, and the fall of the summits is in harmony. A scientific calculation of the dip gives a fall of 1 degree north-north-east. Compare, for instance, the heights of Ingleborough, Simon Fell and Park Fell.

Ingleborough may be considered in further detail as an individual representative of the group of residual table-mountains. The hill has been isolated by the work of the Ribble and the Greta and by the fault-scarp. It stands up, a conspicuous and massive block, 1000 feet above the Limestone Platform on which it rests, more than 2000 feet above the sea. The hill is flat-topped, and the geological map would indicate its protecting cap of Millstone Grit. Erosion on the flanks is reducing its area by carving two waists, which have converted the single top into three summits. Moreover, these summits—Ingleborough, Simon Fell and Park Fell—fall gently north-north-east in accord with the dip of the strata, and Simon Fell has been weathered from flat to round. Contour and hachure both indicate the steepness of slope, especially for the upper 500 feet. The hachuring further shows that these slopes in many cases fall step by step in sympathy with the

alternating bands of resistant limestones and weak shales; here and there, however, the terracing is masked by glacial soils.

Symmetrical Dales.—The work of the surface streams is clear. The Ribble, the Greta and the Kingsdale Beck, fast and straight, have sunk valleys 500 feet and more below the general level of the platform. The valleys are symmetrically sided; they fall, terrace by terrace, down the thickness of the Great Scar Limestone, as is shown by the scars marked and indicated by the sections, to end in the smoother curves of the impervious rocks below. It is the dales which have divided up the mass into isolated fragments — residual table-mountains — Ingleborough, Whernside, Penyghent and so on.

Features indicate the early stage in the Geographical Cycle. Streams are rapid; beds are rocky and boulder-strewn; falls, rapids and gorges mark the courses over the scarp. Valleys are steep-sided; rivers are individual; tributaries are short; there are no marks of capture developments, though some are suggested in the near future.

The Photograph of Ingleborough (Plate VA), taken from near Chapel le Dale on the west side of Gretadale and looking east, is particularly illustrative of the features which the map offers. The flat-topped, steep-edged block of the mountain drops by terraces at its south-western end, resistant limestone bands forming the steep edges. The Great Scar Limestone Platform on which it rests is visible and becomes conspicuous if a magnifying glass be used. The edge of the platform drops by terraces down into Gretadale, the many tiers of rocky scars showing up well. As soon as the base of the limestone is passed, the slopes become smoother and gentler and are covered with walled, grass-grown fields, in which animals are feeding. The "fenced" (with double dry walls) road is visible just below the middle of the view.

Atlas Examples.—Table-mountains and deep, symmetrically sided valleys and gorges are characteristic of that great table-land region of the world, the ancient continent of Gondwanaland, which included eastern South America, Africa, Western Australia, and also the Arabian and Dekkan Tablelands. Mount Roraima in the Guiana Tableland and the Musgrave Mountains in Australia are residual table-mountains. In South Africa many kopjes, often lava-capped, are of this type, and Table Mountain speaks for itself. The square, castellated pillars of the Drakensberg are matched by the similar fastnesses of the Western Ghats. Tibesti in the Sahara is Berber for table-mountain.

LIMESTONE—UNDERGROUND DRAINAGE—A PENNINE KARST

General Description.—The Great Scar Limestone lies horizontally on older, impervious Silurian beds. The limestone itself is traversed by well-marked joints; moreover, under strain it fractures like cast-iron rather than bends like steel. This means that the limestone is seamed with fissures. Through these the percolation of acidulated ground-water is encouraged; the soluble limestone is weak in the face of such attack.

The general results are: (1) the drainage is almost entirely subterranean, with all the corollaries that this implies—swallow-holes, caves, and water-issues, abandoned dry courses and gorges on the surface, underground streams descending by pitches from the top to the bottom of the pervious limestone; (2) the surface of the platform appears in many cases like a massive pavement or clints with the blocks separated by widened joints or grikes, fissures from a few inches to several feet in depth, floored perhaps with turf or fern and sending up a stunted mountain ash here and there.

Swallow-holes.—Rising near the summit of the Ingleborough block and flowing radially outwards, there are

marked on the map and in the accompanying figure a number of sikes or becks. At first they are flowing over the impervious shales and drifts of the fell; they are surface-streams. After courses of half a mile or more they cease

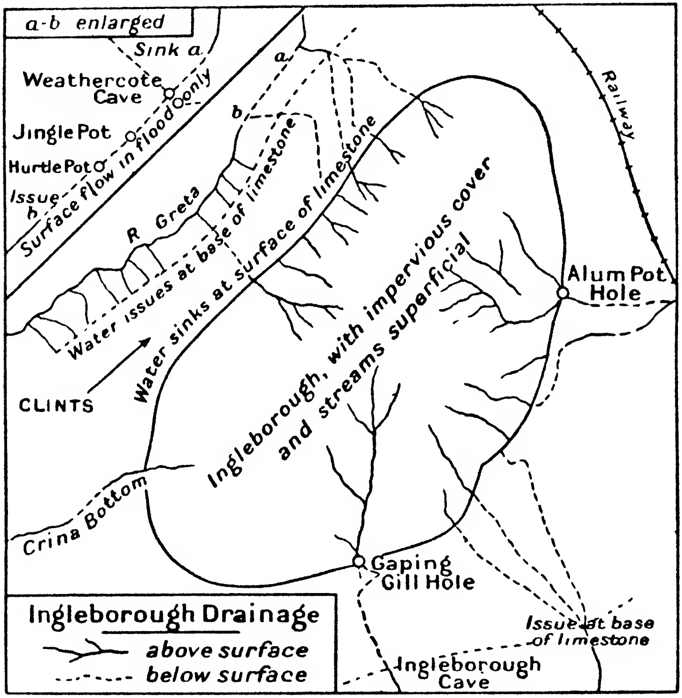

FIG. 21.—THE INGLEBOROUGH DISTRICT—UNDERGROUND DRAINAGE

abruptly on the map; they have reached the upper limit of the Great Scar Limestone. Into this they sink or are swallowed. The case is well seen on the north-west flanks of Simon and Park Fells, where the line of swallow-holes is almost coincident with 1250-foot contour line.

Underground Courses.—In many cases the subterranean

courses descend by a series of pitches; for the joints in the limestone usually pass through one bed only and are not vertically continuous from the top to the bottom of the whole mass. Others, however, drop vertically to great depths down shafts like Gaping Gill Hole, a circular swallow-hole or pot 365 feet deep, and Alum Pot Hole, both on the eastern side of Ingleborough (J, 8: H, 8). There may be, therefore, several sets of streams at different levels, even crossing one under the other, as the water at the bottom of Alum Pot Hole passes under the Ribble.

Water-issues.—In some cases the swallowed beck can be seen to appear along the same line lower down, as in Crina Bottom. At the same time such deductions merely from the map are dangerous. The Yorkshire Geological Society has put in much work in the district and has produced some surprising results by the use of colouring matter. Fell Beck, for instance, after falling into Gaping Gill Hole, first turns due east for a quarter of a mile along a course determined by the direction of the joints and then flows due south along a course which by no means underlies the superficial valley marked on the map, before it issues in Ingleborough Cave.

The Greta, down as far as Chapel le Dale, is continually disappearing underground. In one case, at Weathercote Cave, the roof of the underground channel has collapsed, so that the stream is seen flowing at the bottom of a narrow cavern, into which the excess water of flood time plunges from the usually dry surface channel as well as from a second that lies about ten feet beneath. Into the same cavern, but from the side, an underground tributary from Whernside issues with tremendous force and plunges down 70 feet in a roaring waterfall (see inset).

Below Chapel le Dale and as far down as the scarp the Greta has cut down to the impervious underlying beds; there is no more disappearance. But many becks issue

from the base of the limestone to the east in a line about a hundred yards above the road and join the Greta as shown on the diagram; only a few, however, are shown on the map.

At the upper edge of the Craven Scarp impetuosity begins. The rushing water tumbles over rock ledges like flights of stairs. Forces, pools and strids follow each other in quick succession; here and there the becks are confined in narrow ravines. Baxengill Gorge on the Greta is in one place only two or three yards wide. Thornton Force, on the Kingsdale Beck, drops 30 feet and is the most genuine of the falls. Swilla Glen is a miniature Dovedale.

On the limestone platform lesser streams may have dropped through their gorge floors, leaving dry valleys, as in two cases between Gaping Gill and Ingleborough Cave.

The Photographs (Plate VA and B, and VIA and B) illustrate some of the above features. Plate VB is a view of the clints on the platform opposite Chapel le Dale. It shows how chemical solution has widened the vertical joints, the grikes here being two to four feet deep; the edges of the thin limestone layers have been attacked, too, and look frayed out and tattered. A stunted, twisted mountain ash has found a foothold in the residual soil at the bottom of one trench. The vertical face of a scar, about 20 feet high, forms the background, in which the horizontal stratification with clean-cut horizontal and vertical joints is distinct. Fallen blocks, now being rounded off, lie like a rubbish heap at its base, which short grass is beginning to colonise.

Plate VIA is a view, looking east, of the entry to the deep circular shaft of Gaping Gill (J, 8) on the south-east side of Ingleborough. The platform is here covered with glacial deposits, so that rough mountain pasture covers it and, further, conceals the limestone scars. Fell Beck is seen entering the pot over a boulder-strewn bed, which

would be covered by the swollen torrent after rains. The pot has been described as "a vast black chasm gaping dark and unfathomable in the very track of the rivulet, which, drawn by some horrible attraction to the maw of the abyss, gurgles sparkling out from beneath the limestone slabs again and hurls itself down the pit. . . . Across the black jaw of the chasm there drifts perpetually a dim white smoke, the scattered spray of the broken stream, impinging far below on some shelf of rock, whence it drips down into those subterranean recesses out of which come the waters that whisper so stealthily in the darkness of Ingleborough Cave." Plate VIb is a view of Crummock Beck (J, 8) "issuing" at the foot of Moughton Scars through a low opening, where it has reached the base of the limestone. In the view of Ingleborough (Plate Va) the impress of the shallow valley of one such stream is seen on the right, but the "issue" at the base of the scars is concealed by trees; from this point down the dale becks issue at frequent intervals.

Other Large Scale Illustrations.—If ever in London, the student should examine the geologically-coloured relief model of Ingleborough in the Geological Museum, Jermyn Street. The Peak District, the layered "Tourist" map of the Ordnance Survey, provides excellent examples, not only of table-mountains, like The Peak itself with its steep Blackden and other "edges," but of disappearing rivers and issues and other limestone features; the Peak Cavern at Castleton and gorges like those of Dovedale and the Manifold Valley are well known. Equally well known are the Cheddar Gorge, its caves and issues in the Mendips of Somerset. Similar phenomena are exhibited on the Zara Sheet (Section XXXIII).

Atlas Examples.—Limestone is widely distributed. The type region is the dry Karst which an atlas should mark near the root of the Istrian Peninsula at the head of the

Adriatic, whence swallow-holes, caves, issues, gorges, depressions and other characteristics under various local names extend down the Dinaric Alps. The Causses in the Central Plateau of France with the well-known gorges of the Tarn and the Jonte are French representatives. Perhaps the most popular features are the caves. The Mammoth Cave in Kentucky, the Jenolan Caves in the Blue Mountains of New South Wales and the Cango Caves of the Cape Ranges are familiar. Central Ireland is composed mainly of limestone, and here may be added Loughs Ree and Dearg, which are expansions of the River Shannon due to chemical solution.

References.—A sixpenny pamphlet, *A Guide to the Geological Model of Ingleborough*, published by the Geological Survey, Jermyn Street, London, is well worth getting, both for the descriptive text and for the coloured geological map. The *Proceedings of the Yorkshire Geological Society*, Vols. XIV and XV, have valuable accounts of Ingleborough and the underground drainage of the region. A detailed account of limestone regions is given in De Martonne's *Shorter Physical Geography*, pp. 166–173 (Christophers).

(For the associated human study, see Section XXVII.)

SECTION XVI

FOLDED FORMS—PARALLEL RIDGES AND TROUGHS

AN IRISH JURA

You come to a hair-pin bend, the Devil's Elbow . . . and, when you can safely do so, stop and look back. This is one of the grandest views in the British Isles. Below you lies the great plain . . . with the little white roads criss-crossing through the greenness of the fields and the darker green of the woods. . . . But the road goes on and up into mountains, bare and barren and brown ; then it falls to one of the sweetest glens in the world, where a laughing stream runs beside you all the way.

H. V. Morton : *In Search of Ireland.*

The Map.—Bartholomew's Quarter-inch to the Mile Map of Ireland : Sheet 5, Killarney and Cork. A more detailed map, but more expensive, is the one-inch "Tourist" Edition, Cork District, of the Ordnance Survey of the Irish Free State.

The District Selected.—The neighbourhood of Cork.

General Description.—At the close of the Carboniferous Period the strata of Southern Ireland lay in almost horizontal sheets. Since carboniferous times lateral pressure from the south has compressed them into broad folds whose axes lie west and east, part of a folded system which extends through South Wales and Armorica to the Rhine Highlands. There is a general downward pitch towards the east. Although vast thicknesses of rock have since been removed by denudation, it is still true to say that the coincidence of surface form and underlying

structure is maintained. The structural weakness and the greater exposure of the upfolds together with the solubility of the limestone has led to the comparatively rapid removal of the limestone from their crowns and flanks. The underlying Old Red Sandstone is exposed ; limestone remnants cover some valley floors. But the worn upfolds still form

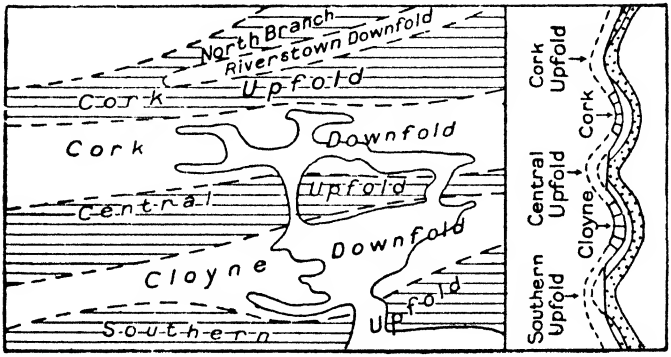

FIG. 22.—THE FOLDS OF SOUTHERN IRELAND—STRUCTURAL PLAN AND SECTION

the ridges and the downfolds the troughs, as the section in the above figure makes clear.

Ridges and Troughs.—The map shows the characteristic parallelism of upfolded ridges and downfolded troughs. There are three main ridges : (1) the Southern Upfold, (2) the Central Upfold, narrowing from three miles to one and sinking eastwards from 500 feet to 300, steep-sided and broken by the water-filled gorges of West Passage and East Passage, (3) the Cork Upfold. These three upfolds enclose two downfolded lengthwise troughs : (1) the Cloyne Downfold, with the River Owenboy, (2) the Cork Downfold, with the Rivers Lee and Bride. They are clearly marked by the east and west expansions of Cork Harbour and Lough Mahon.

The major folding has been complicated by subsidiary

folding. The Cork Upfold, for instance, forks eastwards near Leemount into a northern and southern branch which enclose the Riverstown Downfold.

The View of East Passage, Cork Harbour (Plate VIIA), looks northwards. On the left is the part of the "back" of Great Island which is continued to the right across the narrow, rather gorge-like transverse channel. The left-to-right hill opposite the exit of the channel is a piece of the limestone remnant along the floor of the Cork Downfold; the drowned lengthwise channel extends to right and left on the near side, while the far side of the Cork trough can be seen beyond. In the far background the surface rises towards the next and higher upfolded ridge; in the centre of this it is just possible to make out a small "nick" in the crest, the higher, dry portion of the Owennacurra Valley, of which East Passage is the lower, drowned part.

JURA PATTERN DRAINAGE—LENGTHWISE RIVERS

General Description.—The main streams of South-western Ireland show a striking parallelism along the downfolds, west to east, following the pitch. They all have right-angled turns near their mouths. The lengthwise flow is natural; the right-angled turns and breaches through the upfolds are unexpected.

Consequent Rivers.—The original direction of the rivers was north to south, antecedent to the folding. The story of their birth goes back to the time of the Carboniferous Period, when the rocks lay in nearly horizontal sheets; there was a slight fall southwards. Consequent rivers, therefore, flowed south to the St. George's Channel. This direction is maintained in fact to-day by the Barrow, Nore and Slaney in the south-east, where the folds die out or sink beneath the sea.

Although earth-pressure slowly ridged the strata east-west across the north-south directions of the streams, the eroding power of the consequents maintained their established courses by a downward cutting equal in rapidity to the rate of upfolding. At the close of the folding, then, the consequents still flowed southwards across the upfolds (in gorges) and downfolds (in wide valleys) alike. Such gorge-like constrictions the Lee has at Inishcarra (six miles above Cork), in Passage West below Cork, and at the outlet to Cork Harbour. The Lower Bandon has cut gorges near Rock Castle and Summer Cove. Below Innishannon the walls of the Bandon rise 200 feet above the river.

Subsequent Rivers.—Rapid development of the sub-

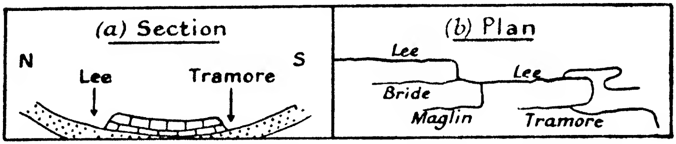

FIG. 23.—POSITION OF SUBSEQUENT TRIBUTARIES NEAR CORK

sequent tributaries was favoured by the trough lines, the banded arrangement, though not the structure, being similar to the case of the Weald in the following Section. As the axes sloped down eastwards, right-bank tributaries were long, left-bank short. Such are the lengthwise parts of the rivers Lee, Bride, Owenboy, Bandon and Argideen.

Often two subsequents occupy one valley, one along each edge of the limestone. Sometimes a stream cuts across the limestone from the north side to the south, as with the Lower Lee and Lower Owenboy (see Fig. 23).

River Piracy.—The guiding lines of the troughs favoured the headward extension of these subsequents. The Glashaboy-Lough Mahon consequent was stronger than, and therefore encroached on, its western neighbour, the Dripsey-Brinney-Lower Bandon. The former beheaded

and annexed the Dripsey. If this is the case, the Dripsey is the betrunked and the Brinney the beheaded portion of a probably once continuous stream. The elbow of capture is near Dripsey Station and the wind-gap is near the head of the Brinney. The Upper Lee continued to extend westwards and would seem to have repeated the process with the Argideen; the last-named river seems to have suffered also at the hands of the Bandon.

The River System of Southern Ireland.—The survey may be profitably extended over the whole of Southern Ireland. The atlas will show the west and east extensions of the parallel ridges and troughs, and of the contained river systems that repeat the plan and history of the Lee. For instance, the Nore and the Barrow mark the original consequent direction, unbroken from north to south; but their next-door neighbour to the west was broken by the subsequent (middle) Suir, so that the present Upper Suir and Lower Blackwater seem to be the severed head and body of an ancient single stream. The marauding process seems to have been repeated by each stream against its western neighbour, as already described. Each present river, therefore, seems to be a compound of parts of three streams. The process accounts for the right-angled turn of each river in its lower course.

Atlas Examples are naturally to be found in the young (tertiary) folded American and Eurasian Cordillera. The typical case is the Jura. But parallelism is clear in Europe in the Alps; in Asia, in Southern Persia, the Himalayas and Burma; in America in the parallel ridges, rivers and strings of lakes of British Columbia, where the Rocky Mountain Trench runs for a thousand miles from near Flathead Lake in Montana to the Yukon and contains a succession of lengthwise head-pieces of the Columbia, Kootenay, Fraser, Peace and other rivers.

Similar drainage systems are to be found in the Balkan

Mountains, where the Tundja has worked back and beheaded a river which once seems to have flowed to the Black Sea from Kazanlik to Burgas, and in the Indo-Chinese Peninsula, where the Chindwin seems to have been severed from what is now the Dihang, the Sittang from the Upper Irrawaddy, the Menam from the Upper Mekong and the Songka from the Upper Yangtse.

Reference.—Jukes: *The River Valleys of the South of Ireland* (Quarterly Journal of the Geological Society, Vol. XVIII).

(For associated human notes, see Section XXIII, Other Large Scale Illustrations.)

SECTION XVII

TILTED FORMS—SCARPED RIDGES AND VALES

THE WEALD OF KENT

I'm just in love with all these three,
The Weald and the Marsh and the Down Countrie.

KIPLING: *A Three Part Song.*

The Map.—Bartholomew's Half-inch Reduced Survey, England:—parts of Sheets 30 and 31, specially mounted together by Messrs. Bartholomew.

The District Selected extends from the Thames on the north to Crowborough on the south, from Edenbridge on the west to Lenham on the east; it is the Maidstone district.

General Description.—This Section is headed "Tilted Forms," and the map is used to represent such in a mature stage of denudation. But the district is, of course, actually the northern flank of the Wealden Upfold, of which the counterpart lies to the south in Sussex. The map may, however, be made to serve the double purpose of illustrating the characteristics of maturely denuded tilted forms which are more exactly exemplified in the next section on Northern Wiltshire, as well as those of maturely denuded folds, comparable to those of the Appalachians.

The beds are dipping towards the Thames. The strata, now exposed, are alternatingly resistant and weak. Since the fundamental elements of the landscape depend upon

the structure and resistance of the rocks which come to the surface, the region now reveals a series of parallel ridges and vales—three bands of uplands, three of lowlands. But, as always in the lowlands of England when contrasted with the lowlands of Scotland, the rocks are essentially soft and destructible, so that hills are low, summits are rounded, slopes are smooth, and the whole is concealed under a carpet of vegetation.

The Three Ridges.—The North Downs, the Ragstone Ridge and the Forest Ridge stand out by reason of rock

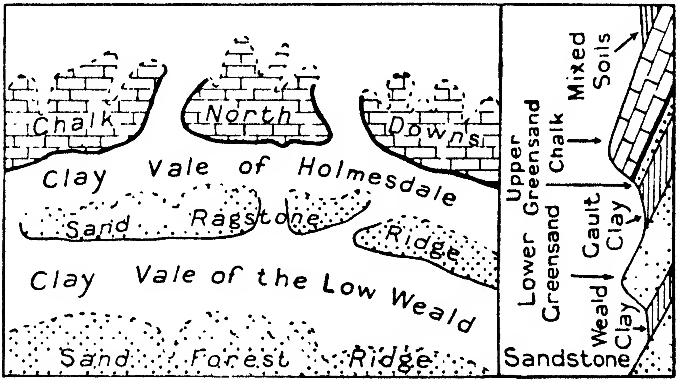

FIG. 24.—THE MAIDSTONE DISTRICT—RELIEF PLAN AND SECTION

resistance. The dip of the strata is northwards at an angle of 5 degrees or less. Resistance accounts for the hill; the tilt gives the form.

The North Downs form a scarped ridge. Built of chalk, they rise 600 feet and present three features: an even crest-line (probably from an earlier cycle of denudation), broken only by the two deep gaps of the Medway and Darent; a short, steep scarp, facing inland, and winding with rounded spur and combe; a long, gentle dip slope, descending towards the Thames and scored with streamless bottoms. *The Ragstone Ridge*, built of Lower Greensand,

lies parallel to the south and repeats in miniature the structure and form of the North Downs—even top, steep infacing scarp, long northward dip-slope. *The Forest Ridge* and its northern slopes are seen along the bottom of the map.

The Three Vales.—Weak clays account for the lowlands; the tilt again gives the form, making the cross-section unsymmetrical. *The Thames Lowland* is the youngest. The surface of the chalk here is covered with gravels, sands and clays of the London Tertiaries. It is lumpy in character, and fringed with island, salt marsh, and estuary. *The Vale of Holmesdale*, between the two scarped ridges, is narrow and undulating; sands are mixed with the clay. The Vale is shut in on the north by the steep, grassy wall of the chalk scarp, while on the south it rises more gently up the back of the Ragstone Ridge. In other words, the vale is unsymmetrical in form and is built of three different groups of rock. *The Vale of the Low Weald*, of Weald Clay, is featureless, so flat that the Southern Railway runs dead straight from Tonbridge to Ashford. There are no contours above 100 feet, and houses seem dispersed at random. It is wider than the Vale of Holmesdale, but otherwise it is a replica, unsymmetrical in cross-section, and threefold in rock composition.

While with the horizontal stratification of Ingleborough the dominant lines are horizontal and vertical, here, as the section shows, the scenic outlines are unsymmetrically oblique. The relief is a perfect fit to the nature of the rocks and their structure.

WEALDEN-PATTERN DRAINAGE—THE ESPALIER TREE

General Description.—Rivers have been the chief agent in shaping the broad features of this belted lowland. In the process their systems have developed a perfect espalier-

pattern adjustment, characteristic of all such regions; technically the pattern is known as "Wealden."

Consequent Main Streams.—When the Wealden arch emerged, the original Medway and Darent flowed over the chalk cover northwards towards the Thames in consequence of the direction of the dip. These old consequent streams, perhaps, are represented by the Upper Medway-Darent, and the Teise-Lower Medway. They proceeded to entrench themselves into and through the chalk cover. In so doing they revealed the underlying beds in succession. They

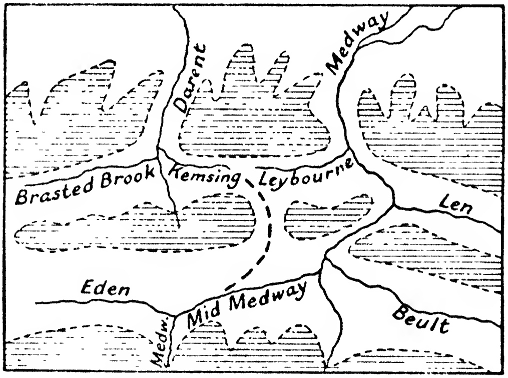

FIG. 25.—THE MAIDSTONE DISTRICT—WEALDEN RIVER SYSTEM

crossed weak and resistant exposures alike, opening wide, marshy valleys in the clays and cutting gorge-like water-gaps through the more resistant ragstone and chalk.

Subsequent Tributaries were developed at right angles along the strike of the weaker clays. Such subsequent tributaries are often called strike streams, Leybourne and Len along the gault, Beult and Middle Medway along the Weald Clay. So the river systems became espalier-pattern.

River Piracy.—The Medway was stronger than the

Darent. By degrading its valley more quickly, the former offered to the Beult and to what is now called the (middle, strike-wise) Medway a lower base-level and so gave them superior cutting power over those belonging to the latter. Hence the middle Medway, extending itself rapidly headwards or westwards, beheaded the Darent and diverted its upper waters into its own stream. The Darent was thus broken in two ; the lower half pursued its old course (the present Darent)—beheaded, weakened and shrunken —and left a wind-gap as a mark of its earlier work. The strengthened Medway continued its vigorous career and is still extending its range further westwards by means of the Eden.

Obsequent Tributaries.—As the clay vales were carved out by the subsequent tributaries the escarpments became exposed. A second set of tributaries, obsequent streams, rose from the springs along the line where the chalk rests on the underlying clays. These streams are clearly anti-dip ; they flow inwards to join the subsequents ; many such can be picked out on the map, rising in combes and forming sites for villages and hamlets.

Thus the harmony between the structural framework and the river system is well-nigh complete. The composition of the rocks and the tilt of the strata determined the pattern of the river-development. The river-development helped to determine the relief, each set of rivers—consequents, subsequents and obsequents—with its own piece of work.

Other Large Scale Illustrations and Atlas Examples.—South-eastern England and the Thames River system are of Wealden type. The Cotswolds and the Chilterns are scarped ridges, dipping south-eastwards. The Cherwell-Thames (Fig. 28) gathers from west and east the Isis (Upper Thames) and the Ock (Vale of White Horse), the Ray and the Thame (Vale of Aylesbury). The Seine Basin

has the same scarped arrangement and the same consequent, subsequent and obsequent rivers. In the United States a large atlas will show the belted arrangement of ridge and vale in Alabama, where the River Alabama has captured the Coosa by the development of a tributary along the Black Belt of the Inner Lowland.

References.—W. M. Davis: *The Development of Certain English Rivers* (Journal of the Royal Geographical Society, Vol. V), and for the Seine the same author's *Geographical Essays*, chapter xxii (Ginn).

(For the associated human study, see Section XXVIII.)

SECTION XVIII

MULTUM IN PARVO—TILTS, FOLDS AND CHALK

A WILTSHIRE DOWNLAND

O bold majestic downs, smooth, fair and lonely ;
O still solitude, only matched in the skies ;
    Perilous in steep places,
    Soft in the level races,
Where sweeping in phantom silence the cloudland flies ;
With lovely undulation of fall and rise ;
Entrenched with thickets thorned,
By delicate, miniature, dainty flowers adorned !

ROBERT BRIDGES : *The Downs.*

The Map.—Ordnance Survey, England—Scale 1/63,360 : Popular Edition, Sheet 112, Marlborough and Devizes (Special Hachured Map, with parish boundaries).

The District Selected.—The western two-thirds of the Sheet, embraced by the co-ordinates 1–9, A–J.

General Description.—Within a distance of less than twenty miles there lies in Northern Wiltshire an epitome of South-eastern England, a compact group of simple surface forms. Here the fundamental dividing line is the escarpment of the chalk; it faces north-west, inland, towards Wales (see Plate VIIB). With the help of the accompanying geological plan and the model (Plate VIII), the five or more closely packed contours and the hachures, which express its steepness, should be followed south-westwards from Chiseldon and Wroughton (under the marginal 8 and 7). Its winding foot is marked by a line of villages—Wroughton, Broad Town, Compton Bassett

to Devizes, to name only a few. Potterne is placed on its lower slopes and the main scarp passes off the south-west corner of the map past the Cheverells. It is worth running over two or three times, for it is the great dividing line of the county. South-east of this line is a high downland, over 500 feet, rolling, dry and grassy; it is built of chalk. To the north-west, the "Garden of Wiltshire" is made up of low limestone ridges and clayey vales, all mainly under 500 feet, and the latter flat, wet and wooded; it is a land of fat meadows, dairy farms and, formerly, of cheese. John Aubrey, a famous Wiltshire naturalist of the seventeenth century, discerned the contrast in the different characters of the people of the two regions. Those of North Wiltshire, "a dirty, clayey country," he says, were dull and heavy and "speake drawlinge," though they were "handsome enough"; they only "milk cowes and make cheese, and the milk meates cool their brains too much." Contrariwise, on the "downes, the south part, where 'tis all upon tillage and where the shepherds labour hard, their flesh is hard, their bodies strong." The former were contemplative and malicious! The latter had no leisure, even for religion!

The accompanying section is drawn across country along the line indicated on the geological plan, from the north-west corner to Marlborough and then due south to Salisbury Plain. The three types of land-forms here dealt with are shown—a north-western belted country of scarped ridges and vales, similar to the Maidstone District; a central synclinal (downfolded) Kennet trough; a southern denuded anticline (upfold)—the Vale of Pewsey, a miniature Weald.

The geological model (Plate VIII) will help in visualising these divisions; it should be consulted frequently in reading the following descriptions. The valley down the middle is that of the Kennet, towards which numerous dry valleys are tributary from the two limbs of the downfold. Only the northern edge of the Vale of Pewsey is shown.

The North-western Scarped Ridges and Vales.—The geological plan shows a series of curving, parallel bands of limestones and clays. From the section it is clear that the overlapping beds are laid down, one resting upon another, alternately weak and resistant, from the oldest clay to the younger chalk. The strata dip towards the south-eastern seas, while inland they outcrop in succession. The

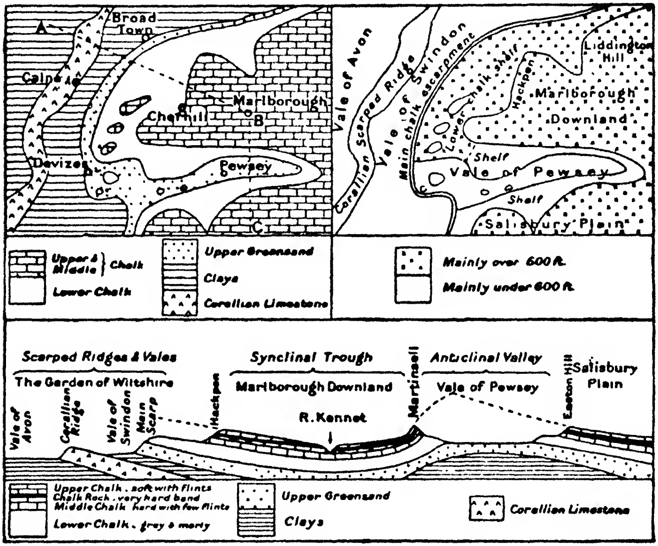

FIG. 26.—NORTH WILTSHIRE

GEOLOGICAL PLAN, RELIEF AND SECTION

weak clays form the Vales of Avon and of Swindon; the resistant Corallian Limestone and Chalk stand up as ridges with their short, steep scarps facing west and north (compare the accompanying Fig. 27).

If, then, the map be scrutinised with these pictures in mind, the Vale of Avon will be seen to cover a triangle in the north-western corner between the edges and the derelict Wilts and Berks Canal. Its height, as shown by spot-

heights, is under 200 feet above the sea. The white blank of the paper immediately suggests flatness and a line of least resistance for the Great Western Railway, but the two ring contours of gravel swells and the embankments and cuttings of the line prove that it is not the dead level of Fenland.

East of the 200-foot level of the canal the close contours reveal the steep rise of the Corallian Scarp up to 500 feet. Its dry back carries patches of woodland and several villages; south-west of Calne it is overlapped by Lower Greensand (see Plate VIII) on which Bowood and Spye

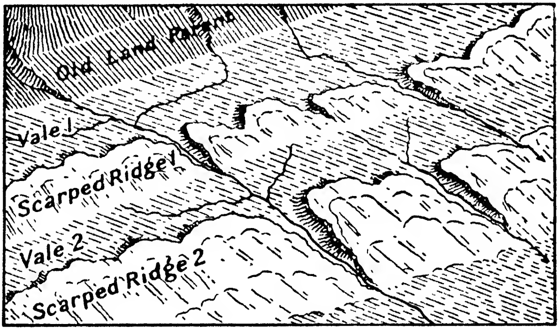

FIG. 27.—SCARPED RIDGES, VALES AND GAPS

Parks repeat those of Sevenoaks on the Maidstone Sheet and which gives a reason for the name of Sandy Lane (E, 1). From the summit of the ridge the monument to Maud Heath (C, 1) looks benevolently down over the wet Vale of Avon, to build a causeway across which she left her savings.

Here, in fact, is almost a replica of the alternating scarped ridges and vales of the Maidstone District with the difference that dip-slopes and scarps face the opposite way and that the Corallian Limestone replaces the Ragstone Ridge. We should look expectantly for a Wealden

system of drainage and we find traces of its espalier pattern, but again with a difference in that it flows unexpectedly in a reversed direction against the dip, perhaps because of the subsidence of the Bristol Channel and the masterful power of the Bristol Avon. The Wealden scheme of drainage is, however, repeated in pattern further east (Fig. 28 and see p. 108).

Further north-west beyond this sheet the ground rises again to the greater scarped ridge of the Cotswolds and drops again over its edge to the Vale of Severn.

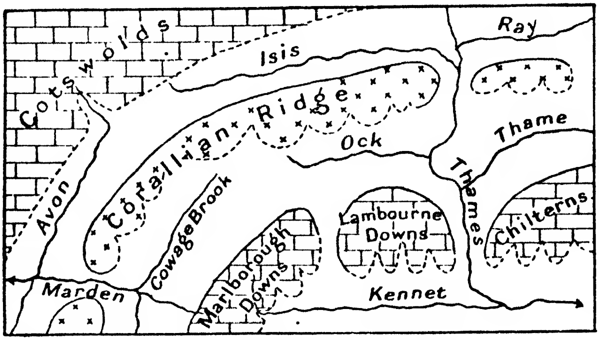

FIG. 28.—RIVERS OF NORTH WILTS AND BERKS

The Kennet Downfold.—The main Bath-London road lies west to east across the centre of the map, hand in hand with the River Kennet. The altitude is in the neighbourhood of 500 feet. Three miles to the south of this line the crest of the Chalk Downs rises to over 900 feet in the ridge from Roundway Hill (F, 3) to Martinsell (F, 8); north of the Kennet the Marlborough Downs rise also, but in double the distance, to some 900 feet at Hackpen Hill (C, 6) and at Liddington Hill (A, 9). The continuity of this northern ridge is broken by the valley of the River Og, easily found by the north-south road and railway which follow it. These heights, rising away from the river, are the surface expression of an unsymmetrical

downfold, on the floor of which the River Kennet flows. The eastward direction of the river suggests that the whole trough has a downward pitch in that direction, and such a tilt would conform to the dip of the ridge and vale country of the north-west, already studied. The Kennet trough is the narrowed head of the London Basin.

Now the geological plan and section disclose three chalks—upper, middle and lower—the last of which is distinctly clayey. Between Hackpen Hill (C, 6) and the main chalk escarpment the upper and middle chalks have been peeled back, as it were, by denudation, and the lower chalk is exposed as a broad bench of cultivation; its extent is shown in the diagram of physical divisions, and it appears clearly on the photograph of the model. The chalk scarp, therefore, is double-stepped between Chiseldon (A, 8) and Avebury (D, 5). The Upper Kennet and a main road run along the middle of this bench.

An Anticlinal Valley—the Vale of Pewsey has the outline of a narrow isosceles triangle. From its apex at Marten (G, 11) it expands for seventeen miles westwards to a base of five miles between Devizes (G, 2) and West Lavington (J, 2). Here it breaks the continuity of the chalk of the main scarp, outlined at the beginning of this study. It drops, however, over the Upper Greensand on to the clay vale below, as the succession of twenty-nine locks at Devizes testifies. The two walls of the Vale, infacing towards each other, are of Middle and Upper Chalk, from beneath which marginal ledges of unconsumed Lower Chalk project for some distance and lead down to the floor of Upper Greensand. The geological plan and section should make these details clear and enable the vale to be traced out on the map. When one crosses from the Kennet Downfold to the Vale of Pewsey one passes from the London to the Hampshire Basin. The northern scarp of the vale is intact, but is recessed here and there, like most of the chalk

scarps, by narrow ravines and rounded combes. Both can be found on the map, and of the latter Rainscombe (F, 7), embosomed in Oare Hill and defined by a pointed spur, exhibits a perfection of curve not often met with. The beauty of its pale grassy slopes is increased, especially in autumn, by the dark green bushes of gorse and juniper against which are set the golds and browns of the beech trees. The southern scarp is broken by the gaps of two streams, the Salisbury Avon near Upavon in the middle and the Bourne towards the east, which flow to the English Channel.

Such is the vale in plan. The section (Fig. 26) shows that

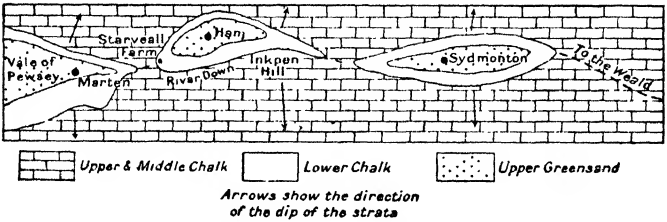

FIG. 29.—LINE OF CANOE-SHAPED VALLEYS ALONG THE CREST OF AN UPFOLD

the original form was an upfold with a west-east axis, and an upfold, being weak in structure, is soon notched along the crown of the arch into a canoe-shaped valley, or series of such. Further east and set end to end with the Vale of Pewsey is the canoe-shaped Ham Valley, which extends from Starveall Farm (G, 11) (auspicious name!) to the village of Inkpen (F, 13). Its southern scarp (Rivar Down, Ham Hill, and Inkpen Hill) is clear cut on the map; its northern wall is less conspicuous. The series is continued eastwards, just off the map, to the similar Sydmonton Valley (see Fig. 29).

The origin of the Vale of Pewsey with its open western end has occasioned some speculation. It matches the denuded upfold of the Weald, whose eastern end

near Boulogne is cut off by the gash of the Straits of Dover. It seems simplest to regard the Vale of Pewsey as an ancient canoe-shaped valley, like the present Ham and Sydmonton Valleys; the closed western end was removed by the recession of the main chalk scarp, as it was undermined by springs and streams, and as it is still being cut back eastwards, down the dip, by streams and valleys which re-entrant contours, north and south of Potterne (H, 2), clearly show.

CHALK—THE DOWNS

General Description.—Here in Northern Wiltshire is the largest compact area of true, unspoilt Downland in England, a reminder of what the greater Salisbury Plain might have been but for military needs. One can wander for miles across its springy turf, enjoy its wide horizons and breathe its stimulating air. Its gentle convex outlines are "the most perfect specimens of graceful contour." Any possibility of monotony is removed by the patches of white chalk that gleam through its thin soil-cover, by the clumps of beech that dot its summits and the hanging woods that clothe some of its slopes, by the constant change in atmospheric effects. The Downland is at its finest when the changing lights of an angry sky race across its broad expanses.

Underground Drainage.—Chalk is porous; it absorbs and holds water like a sponge. Chalk, too, is a limestone, soluble in acidulated ground water, as was the case round Ingleborough. It is said that every year the Thames is carrying away in solution 140 tons of chalk from each square mile of its basin. Not unexpectedly, the drainage is subterranean, except for the gathering ground along the bottom of the trough where the Kennet appears. The river at Lockeridge House (E, 7) is a small brook;

by the time it has reached Marlborough it has become a considerable stream without any surface feeders. Although the Chalk Lands resemble Ingleborough in underground drainage, the substance of chalk is soft as compared with the Great Scar Limestone, so that rounded spurs take the place of rocky scars.

Spurs and Dry Valleys.—The most characteristic feature of the heart of the chalk country, as opposed to the scarps, are the " blunt, bow-headed, whale-backed " spurs and dry " bottoms." They can be traced on the map south of the Kennet, where two carry roads south-westwards to cols that notch the scarp. North of the Kennet a tree-like pattern of dry valleys is impressed deep into the Marlborough Downs; they converge on Rockley (C, 7) and, united, lead to the Og at Bay Bridge (D, 8). Their origin has been variously ascribed to chemical solution, the scour at the break up of the Ice Age, and, more recently and more probably, to the work of former superficial streams which have since sunk beneath the surface; for, as the clay vales became deepened and the scarps receded down the dip, the scarp springs, and with them the saturation level of the downfold, were lowered in harmony.

Winterbournes.—Some of the valleys carry running water in the early part of the year after a wet autumn, and hence are known as Winterbournes, a description often applied to village names, as along the Upper Kennet. The Kennet itself dries up in summer above the strong Swallowhead Springs (E, 5); in 1929 it was dry above Marlborough. Similarly, the Og is intermittent. In this trait, as well as in their rapid currents over clean, pebbly beds, the chalk streams contrast with those of the clay vales, where brooks are sluggish and muddy, but many and permanent.

White Horses and Sarsen Stones.—There is no space

but to mention two other features. "White Horses" are often cut on chalk escarpments. Four are marked on this sheet, *e.g.* on Hackpen Hill (B, 6), Cherhill Down (D, 4), above the Altons (F, 5) and close to Marlborough (E, 8). The second feature is the number of greywethers or sarsen stones, that are localised, as the map shows, in Lockeridge Dean (E, 7) and more plentifully all over Totterdown (D, 6 and 7). A "stream" of these huge stones extends down "The Valley of the Rocks," now a national possession, towards the Kennet, west of Fyfield (D, 6). Of them the Avebury Circles were built, and they form part of many a cottage, barn and wall. Some of the Avebury stones weigh 70 tons. Sarsens, grey and lichen-covered, seem to be residuals from a soft, superficial cover, now disappeared.

Other Large Scale Illustrations.—Almost any of the one-inch sheets of the Ordnance Survey that cover the "hand" or "fingers" of the chalk mentioned below, except in East Anglia, will give further illustrations. The scarp, spurs and dry bottoms are well seen in the map of the Maidstone District, which was studied from other aspects in the preceding section.

Atlas Examples.—The distribution of the chalk in England should be followed on a geological map and compared with a map of the relief. From a "hand" in Wilts and Dorset the chalk sends out four scarped ridges to end in the cliffs of Flamborough Head, Dover Cliffs, Beachy Head and in the backbone of the Isle of Wight. If it is remembered that the London and Hampshire Basins are downfolded, with the Wealden Upfold between, the scarps, dip-slopes and rivers can be visualised.

(For the associated human study, see Section XXXI.)

SECTION XIX

A DENUDED DOME—RADIAL RIDGES AND FURROWS

CUMBRIA

Both a natural museum of physical geography and a thing of beauty.

F. J. CAMPBELL : *Cumbria.*

The Map.—Bartholomew's Half-inch Reduced Survey, England—Scale 1/126,720 : Sheet 3, Cumberland. There is also a One-inch "Tourist" Edition, the Lake District, of the Ordnance Survey.

The District Selected.—The Lake District in the middle of the sheet.

General Description.—The region of the map falls into three main divisions. First, to the north-east the triangle of dark brown colouring represents part of the Western Pennines, rising in Cross Fell nearly to 3000 feet. Its steep western edge is due to dislocation along the Pennine Fault, a clear-cut scarp except in so far as it has been frayed out by torrents. Secondly, the Cumbrian Dome forms the heart of the map. Thirdly, the Dome is surrounded by a girdle of three interconnected lowlands, Edendale on the east, the Carlisle Lowland on the north, the narrow coast lowland on the west.

If a circle be drawn with its centre at Helvellyn (east of Thirlmere) and with a radius of sixteen miles, it will include all the land over 1000 feet, as well as all the lakes

and tarns belonging to the Lake District. The rugged massif is thus separated from the Pennines by the valley of the River Eden, though joined further south by the back of Shap Fell.

Geologically, the dome consists of a core of complicated igneous and metamorphic rocks, surrounded by a ring of

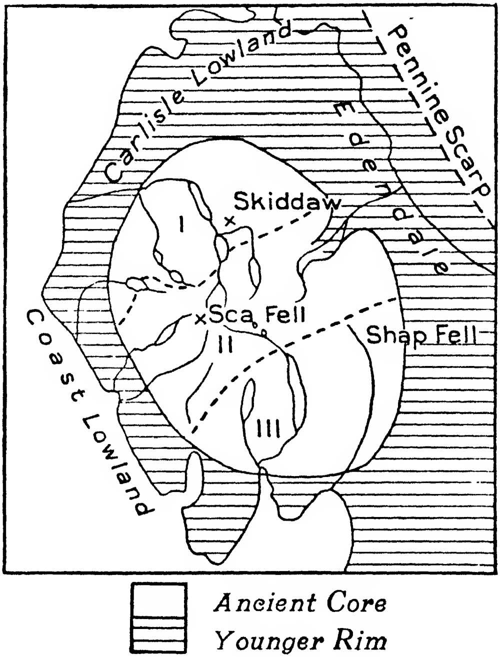

FIG. 30.—CUMBRIA—GEOLOGICAL PLAN

younger, surviving limestones, sandstones and coal measures. The upwelling of the igneous core may indeed have caused the elevation of the dome. The variety of scenic detail is due in part to the variety of rocks. The core itself is threefold, as the accompanying diagram shows : the relatively weak Skiddaw slates (I) result in the smooth outlines of Skiddaw, north of Keswick ; the weak

Silurian grits and shales (III) allow lower, milder scenery round Windermere; the tough volcanic centre (II) shows in savage crags and precipices from Wastwater to Ullswater and is seen on Scafell and Helvellyn. A study of the illustrations (Plates IX and X), in conjunction with the map and the diagram, should help towards picturing the variety of landscapes behind the map. For instance, the view of Ullswater, looking towards the Pennines on the far horizon, shows up the contrast between the rugged volcanic surfaces of Place Fell and Flat Crag on the right and the milder scenery of the Skiddaw Slates of Barton Fell near the end of the lake. The view of Thirlmere is rough and shaggy from the volcanic rocks of Raven Crag (left) and High Rigg (right), as compared with the smoother outlines of Saddleback (right), Calva (centre) and Skiddaw (left) in the far background. The view of the Rosthwaite Basin also shows the rough landscapes of the Borrowdale Volcanic Series. Ennerdale on the map, narrow among the volcanic rocks, widens as soon as it enters the weaker slates at its lower end.

Radial Valleys.—The relative resistance of the rocks is only half the story. The other half is the nature of the attack—running water and, later, ice—and to this we must now turn.

The main valleys radiate like the spokes of a wheel. The explanation of this radial symmetry is that the river system was initiated in a previous period on an original dome of now vanished rock, the summit of which lay between Scafell and Helvellyn, and the relics of which lie in the surrounding rim of aqueous rocks. The rivers flowed fast down the steep slopes of the dome; they were often in spate over the rain-drenched highlands. So they bit deeply and by degrees stripped off the cover.

Ten or more such radial streams and valleys may be counted and named from the map; most of them expand into finger lakes. These radiating valleys are deep and

steep-sided. Some rivers, like the Derwent and those of Windermere, having a greater catchment area and therefore a greater volume than others, have advanced further in their life-work of grading their profiles; this may be illustrated by comparing the more open Borrowdale with Ennerdale in the west or Langdale in the south.

Passes.—The main streams have eaten headwards into the heart of the dome. Set back to back, as it were, they have lowered the intervening water-parting at their sources; cols or passes have been formed, linking the head of one valley with that of another. Thus, Stye Head Pass (1600 feet) joins Borrowdale to Wastwater; Stake Pass (1581 feet) joins Langdale to Langstrath; Kirkstone Pass (1476 feet) joins Ullswater to Windermere. The lowest crossing, however, near Dunmail Raise (783 feet), lies between Grasmere and Thirlmere, the central link in a long trench from Windermere to Bassenthwaite Lake; it carries the main road from south to north through the heart of Lakeland and contains the two largest towns, Ambleside (2500) and Keswick (4000).

Intervening Ridges.—The radial valleys connote radial ribs of residual high ground, down the flanks of which run tributary becks. The first stage in the break up of a ridge is the notching of the valley flank. The ridge between Ennerdale and Buttermere-Crummock Water gives a simple map illustration. Several becks and ghylls are marked. The closeness of the contours imply their rapid descent, broken here and there by falls and forces (Scale Force). The straightness of the contours in Ennerdale shows that the notching of the rib by tributaries has barely begun. On the north side, however, the upper contours exhibit crescentic hollows at the heads of streams, while Mosedale Beck has already removed a considerable quantity of the mountain side in carving out its long, deep valley. In several cases antithetic becks have lowered the

intervening ridge more conspicuously, and in two cases, at Scarth Gap and at the head of Mosedale, pony tracks make practical use of the lowered crest-line. The illustration on Plate XIIA shows some destructive work begun ; heavy rainstorms have ploughed deep furrows in the flank of the Watendlath Valley, south of Derwentwater, and laid down " fans " of debris, now grass-covered, at the foot of each. A copse seems to have been planted in the right-hand ravine to check future erosion.

A further stage in the dissection of an intervening ridge may be seen on the map in that between Crummock Water and the Derwent Valley. The tributary valleys of the rib are deeper and cut further back. They are more frequent and run in all directions. The outline of the crest is more irregular, both horizontally and vertically. Passes have been cut lower, so that here they are practicable not only for tracks, as through Caledale Pass, but also for roads, as through Whinlatter Pass and via a tributary of Newlands Beck to Sail Beck.

The Work of Ice.—By the time of the Ice Age the rivers had firmly established their courses in the present radial arrangement of rib and valley. The effect of glaciation was only to modify the outlines already settled.

At the time of maximum growth; when both valley and ridge were buried, the ice-sheet was scraping and polishing everything beneath it, summit and hollow alike ; it has left for to-day many rounded forms. To this maximum period also is due the accumulation of debris that gives the surrounding lowlands much of their lumpy character.

As the cold period decreased in intensity, the ice shrank back inwards and upwards. The ridges emerged, but glacier tongues, fed by the snow and ice of the central summits, still pushed down the valleys. They have handed down, as a heritage, traits similar to those described on the Kingussie Sheet (pp. 70-73).

All the main valleys are U-shaped ; some of them are

broken-bedded, descending by pitches or, like Thirlmere and Elter Water, showing lake-filled rock-basins. As the valley glaciers melted back, they left behind terminal moraines, crescentic bars of rubbish athwart and pointing down-valley. They are not demonstrable with such wide-spaced contours, but they now dam back some of the lakes, Bassenthwaite and Windermere, and some of the tarns. As in Glen Feshie, spurs were truncated ; they are clearly blunted on the south side of Saddleback along the valley of the Glenderamackin, which leads the railway to Keswick from the east.

Hanging valleys with associated cliff-girt cirques (the corries of Scotland), tarns and terminal falls can be seen on all sides, facing the cold north or east. Red Tarn and Striding Edge on Helvellyn, Bleaberry Tarn and Red Pike overlooking Buttermere and the double-stepped Codale and Easedale Tarns, looking from the north-west towards Grasmere, are well known. Of longer hanging valleys the upper steady stretch and final dive of the Measand Beck into Hawes Water give a clear example on the map. A fine series can also be traced on the map overhanging Borrowdale and its two upper forks, Langstrath and the Derwent Valley. Into the over-deepened Upper Derwent Valley the hanging valleys of Stye Head Gill and Sour Milk Gill above Seathwaite clearly fall from the west, and a still more striking example is the long Watendlath Valley, which alternates level pitches and short steps, until its beck plunges down the Lodore Falls on to the flats at the head of Derwentwater. But hanging valleys can be found all over the map, and we may merely add that Sour Milk Gill is a common name for torrents occupying such valleys. One has just been mentioned ; another rises in Bleaberry Tarn and drops into Buttermere, and a third drains Easedale Tarn towards Grasmere.

Post-glacial Modifications.—After the liberation of the district from its bondage to the ice normal agents of

denudation resumed their interrupted work. The outlines, due to pre-glacial streams and to the super-imposed work of ice, have, however, been modified only in detail. The higher summits may display the angularities of frost-splintering, and the famous screes of Wastwater are fallen accumulations of frost-riven rocks that narrow the lake; they are marked on the map. Streams are here and there removing accumulations of morainic debris. But more conspicuous are the steep, fan-shaped alluvial cones at the mouths of some tributary valleys, as the illustration of the Rosthwaite flats (Plate XB) seems to show at the mouth of the hanging valley in the middle of the picture.

The Stage in the Geographical Cycle.—Falls and lakes are traits of an early stage. But here differences of relief are at their greatest, and the profiles of the main valleys are well advanced towards flattened curves—both features characteristic of early maturity. The stage seems transitional, when contrasts are strong.

So the rôle of the Lake Country in the wider life of England lies especially in the peace of its remoteness, in the compelling attraction of its varied scenery—pike and fell, dale and combe, moor and woodland, mere and tarn.

To this end the many factors that go to make a landscape have been laid under contribution. The variety is based partly on contrasted smooth and shaggy surfaces; it is based, too, on the different impress of running water and moving ice. Immature torrent valleys and rushing "forces" are set beside temporary lake basins and quiet deltaic flats. In close neighbourhood are to be found the wild grandeur of frowning precipice and the unruffled calm of placid tarn. Frost, too, has opposed the sharp angles of splintered summits against ice-rounded slopes and naked screes below. It is good to know that part of

the Lake District, at any rate, is secure as a national possession, a thing of beauty and a joy for ever.

But " ever " is a word without significance to the geomorphologist. Broken by frost, fretted by wind-borne dust, beaten and washed by rain, etched by gills and becks and eroded by rivers, the Lake Dome will eventually be reduced, unless accidents happen. Summits and ribs will be levelled. Valleys will become gently graded and streams sluggish; lakes will be filled up or drained. Tributaries from hanging valleys will have cut out their falls and adjusted their junctions. All work, in fact, will have been completed and the region will be resting quietly in its final stage.

Reference.—J. E. Marr: *The Geology of the Lake District* (Cambridge Press).

A CHAPTER IN LAKE HISTORY

General Description.—Lake and valley agree in contour. Coniston Water is straight, Haweswater is curved, and Ullswater is winding in three stretches. Derwentwater is broad, Coniston narrow, while Ennerdale Water is narrow at its upper end and broadens at its foot. The narrow lakes are deep, averaging some 60 feet; the broad are shallow, averaging some 20 feet. Gentle slopes above lead to gentle slopes below; above-water cliffs go down deep below, as under the cliffs of Crummock Water the lead descends 70 feet at only 8 feet from the shore.

Causes of the Lakes.—Several theories are advanced to account for the lakes. Such river expansions as these suggest blocks below which could be supplied by the drift or moraine left by some ancient glacier. Ullswater is said to flow out over such morainic debris. The dam thus formed may be of such a height as to cause diversion of

outflow across a lower escape, as the present outflow of the Derwent leaves at one side instead of along the original valley shown on the map and utilised by the present railway to Cockermouth.

Glacial debris, however, cannot be found at the foot of all the lakes. Nor will all the facts revealed by soundings conform to the dam theory; for instance, if lakes were merely drowned valleys, they should deepen uniformly down-lake, but Buttermere is deepest at its upper end, and Windermere consists of two basins with the lip at Belle Isle, which is only 12 feet below the surface. Again, the surface of Wastwater is 200 feet above sea-level, but the lake is 250 feet deep, that is, its floor is 50 feet below sea-level. Similarly, Windermere goes down 90 feet below sea-level. Such erosion below sea-level is impossible for a stream. Hence, the advocates of the glacial theory ascribe the basins to the gouging of ancient glaciers.

Other geologists would have it that, after the erosion of the valleys, the rim of the Lake District was slightly warped up by earth-movements, and that thus the river water was ponded back. The inward direction of the drainage from Lowes Water into Crummock Water, instead of north-westwards through a clearly marked gap, its original direction, seems to support this view.

The sum of the matter would seem to be that all these methods have played their parts, either separately or in combination.

Up-lake Deltas.—A lake is only a temporary feature in the Geographical Cycle and is a mark of the early stage. It is filled up at its head and sides by stream deposits and along its higher flanks by frost-loosened fragments; at its foot stream erosion lowers its outlet and therefore also the height of its waters.

In times of heavy rains the mountain becks are full, heavily laden with both water and land-waste. Dropped on entering the lake owing to checks in velocity, the

debris first shallows the water, then converts it into marsh, and finally forms flat tongues of dry land which gradually push their way down-lake. The flats so formed may be read from the map at any of the lake heads—blunt-headed in Buttermere, irregular where the stream has been thrust to one side, as in Derwentwater.

Lateral Deltas.—Similarly, lateral brooks build out deltas from the edges. Troutbeck in Windermere, Glenridding Beck in Ullswater and many others show this delta construction at work. The finest example, however, lies in Haweswater: Measand Beck, dropping from its hanging valley, has narrowed the lake from half a mile to a hundred yards at the Straits and separated "High" from "Low" Water. A similar conspicuous example was provided by a western beck in Thirlmere, before the Manchester Corporation raised the level of the water by converting it into a reservoir.

Such delta-building often proceeds at a rapid pace, a foot a year. A large boulder on the Yewdale Beck flat in Coniston Lake which was surrounded by water twenty years ago now lies 20 feet or more inland. Evidently then the Measand Beck delta will not be long before it severs Haweswater completely.[1] Such severance completed is seen in Derwentwater-Bassenthwaite and in Buttermere-Crummock.

Extinct Lakes.—By this process of deposition at the head and sides a lake is eventually filled up; water is replaced by meadow flats. Extinction has been nearly reached in Grasmere, Rydal Water and Elter Water, all of which have a considerable margin of low-level gravels and alluvium. Extinction has been quite reached in the round meadow-basins near Rosthwaite in Borrowdale, in Langdale above the village, and elsewhere over the map.

[1] This statement refers to the indications on the map. Actually the Manchester Corporation is converting the lake into a reservoir.

The Series of Four Photographs illustrates the process at work (Plates IX and X). The three reaches of winding Ullswater show little modification. In Thirlmere, as it was, a western beck has built its delta well out into the lake. The third view shows the severance completed by Sail Beck from the right; the old single lake has become two, Buttermere and Crummock Water. This view shows also the delta built at the head of Buttermere by two streams and a baby delta on the right. The fourth view, of the Rosthwaite Basin, shows the process completed; the old lake has been converted into meadow-flats.

Character of the Deltas.—The delta which separates Derwentwater from Bassenthwaite Lake has been formed by several lateral streams, the Greta, Newlands Beck, Colesdale Beck and others. The green colouring means, that it is low; the parallelism of the Derwent, Powbeck and Newlands Beck and the difficulty of entry by the side streams show its flatness. Sometimes, after heavy rains, the whole delta is flooded and the two lakes become united again into one continuous sheet of water.

The Buttermere delta, formed by Sail Beck coming down from the east, has pushed the connecting stream to the western side. Similar thrusts of stream courses may be seen in the conspicuous bends of the Liza in Ennerdale where Deep Gill joins, in Mardale at the head of Haweswater, where Riggindale Beck joins, and in other places.

The lie of the roads further illustrates the marshy, unconsolidated character of the deltas; they either cling to the flank or cross at the upper ends. The heads of Thirlmere, Derwentwater and Bassenthwaite all illustrate this guidance.

Atlas Examples of " finger " lakes are features of mountain regions. There are many in the Scottish Highlands and North Wales. There are notable examples on both the Swiss and Italian sides of the Alps, the names of which

can be learnt from the atlas. New Zealand has a fine series in the Southern Alps, Lakes Wanaka, Wakatipu and Te Anau, which contrast with the rounded Lake Taupo on the central lava platform of North Island. British Columbia has a series of lakes of similar " arrow " pattern, but lengthwise, not transverse—the Kootenay, Arrow and Okanagan Lakes.

(For the associated human study, see Section XXIII.)

SECTION XX

VULCANISM—CONES, CRATERS AND CRATER-LAKES

VESUVIUS AND THE PHLEGRAEAN FIELDS

There stood a hill not far whose grisly top
Belch'd fire and rowling smoak; the rest entire
Shon with a glossie scurff.

MILTON: *Paradise Lost.*

The Map.—Italy, Istituto Geografico Militare—Scale 1/100,000: Sheet 184, Napoli.

The District Selected.—The southern, shaded half to the west and east of Naples.

General Description.—The effects of vulcanism on relief are twofold. The violent explosion builds the cone, the quiet fissure eruption builds the lava sheet. Only the former is illustrated here, by the cones of Vesuvius and Monte Nuovo, the extinct volcanoes and crater-lakes of the Phlegraean Fields.

Vesuvius.—The truncated cone stands out with great clearness owing to the excellence of the cartographer's skill with the pictorial hill-shading and to the concentric contours at 50-metre intervals. The highest point is 1223 metres. The map distinguishes the three chief features of the mountain. The central cone rises steeply to a blunted summit, where the precipitous walls of the crater are clearly delineated. The upper part of the cone is surrounded by the collar-like ring of Monte Somma, the unbroken part of an old crater rim which must have been

four or five miles in diameter. The southern section of the old rim was broken down by the explosion which built the present interior cone—probably the one which destroyed Pompeii and Herculaneum in 79 A.D. The valley between the collar and the cone is called Atrio del Cavallo and is covered with ash and slaggy or ropy lava.

The conical form is further emphasised by the radial lava flows of the south and the west. In the eruption of 1872 Professor Palmeira, who had charge of the observatory which is marked on the map, described Vesuvius as "sweating lava," so many were the fissures from summit to base. The flow of 1895-9, which is marked, destroyed part of Cook's tramway. Temperatures of 2000° F. were recorded. The radial drainage and radial valleys give the mountain a ribbed appearance and also point to the conical form. In the porous tuff, ash and lava most of the streams seem to die away before reaching the base.

Monte Nuovo, about two miles west-north-west of Pozzuoli, is the result of the latest outburst of activity. The map shows a small truncated cone, 140 metres high, with steep slopes and precipitous crater. It was built in twelve hours on 29th-30th September 1538. For two years prior to this date the district had been disturbed by earthquakes, which on 27th and 28th September became almost continuous. The low shore was slightly elevated, so that the sea retreated, leaving a bare strip, 200 yards in width. The surface cracked, steam escaped, and on the 29th a great rent was made from which were "vomited forth furiously smoke, stones and mud, making at the time of its opening a noise like the loudest thunder." Every sign of activity has long since disappeared.

The Phlegraean Fields exhibit a group of volcanoes in various stages of ruin. The craters of this region are broad in comparison with their depth, as Piano di Quarta well illustrates. Rims, broken by later outbursts, are shown in

the threefold crescent of Monte Spaccata, in Soccavo and at Baja. The rims of the later Astroni, Campiglione and Agnano are all but complete. All show characteristic precipitous interior slopes.

Although signs of dying volcanic activity are represented by the hot waters and vapours of the *solfatara* near Pozzuoli and by the carbonic acid fumes of the *mofette* near Agnano, yet the villages in the bottom of the craters of Piano di Quarta and Pianura, as well as the trees marked on the map (chestnut, stone pine and poplar), are proof of the quiescence of the region.

The Crater-lake Avernus is circular with a diameter of half a mile, 200 feet deep and steep-sided. With the sealing of the crater-shaft water may collect in the cup-shaped hollow. If the material of the floor is impervious, a lake results with the above characteristics. Many craters, however, remain dry, either because their floors are porous or because some exterior stream has cut down the rim and drained the lake. Thus in the Phlegraean Fields Avernus has a complete lake, Astroni a few insignificant lakelets, Pianura and others are dry. Agnano once held a lake but was drained in 1870, and the crater is now a royal game preserve. In the island of Ischia a crater-lake has been made into a harbour and an attempt was made to use Avernus in a similar way, until Monte Nuovo blocked the channel.

Atlas Examples.—Volcanoes run in lines along belts where earth strain is greatest. The outstanding example is the circle round the Pacific: Mt. Fuji in Japan, Mt. Mayon in the Philippines and Mt. Taranaki (Egmont) in New Zealand excel in the sweeping symmetrical curves of their cones. On the American side the extinct Mt. Shasta in California, Mt. Orizaba in Mexico and the "avenue" of volcanoes in Ecuador are a few out of many. The lines of both East and West Indies are in part volcanic.

The highest mountains of Africa are cones thrown out on the back of the African Tableland (Kenya, Kilima-njaro, Cameroons Peak). In Europe the curve along the fracture lines of the west coast of Italy displays examples of cones and crater-lakes from Lake Bracciano in Central Italy through the Alban Hills and Lakes near Rome, the Phlegraean Fields and Vesuvius to the Lipari Islands and Etna. A well-known chain of extinct *puys* runs north to south through the Auvergne. Mt. Hecla in Iceland heads a chain that curves through the Azores and Southern Atlantic. The " High " islands of the Pacific are volcanic.

A world geological map in an atlas will show the many basalt flows. A few examples are Antrim and some of the Western Isles of Scotland, the north-western tablelands of the Dekkan, the Columbia Lava Tableland in the north-west of the United States, the Darling Downs in Australia.

Reference.—J. W. Judd: *Volcanoes* (Routledge).

(For associated human notes, see Section XXV.)

SECTION XXI

FRACTURED RELIEF—FAULT-SCARPS AND VALLEYS

Seems that primeval earthquake's sway
Hath rent a strange and shattered way
Through the rude bosom of the hill.
SCOTT : *Lord of the Isles.*

The Maps.—As for the last Section, Cumberland, and for Section XXXI, Oban.

The Districts Selected.—The Pennine Scarp and the Pass of Brander.

General Description.—The consequences of fracture upon relief are mainly twofold. First, dislocation along fracture lines often results in scarps, characterised by straightness. Secondly, valleys often result owing to the weakness of a fracture line in the face of erosion.

The Pennine Fault-scarp.—The steep wall, which rises 500 feet above Ingleton with a slope of some 5 degrees, is due to displacement along the line of the Craven and other faults. The downthrow was on the west and amounted to something like 5000 feet or nearly a mile. A similar but steeper scarp wall rises 1000 feet between Edendale and the Pennines on the north-east of the Cumberland Sheet ; it is just discernible in the background of Plate IXA. The edges of both run straight, aligned from north-west to south-east, but are being frayed into ragged edges by the work of springs and by torrents. The abrupt descent

of the lower slopes has been softened by the waste from above. Fault-scarps thus frequently define the margins of crust-blocks and basins or rift-valleys.

The scarp torrents, which bite down into the wall in frequent gorges, as well as the undermining of the springs, eventually lower the wall of the scarp, so that summit and plain lie along the same level. All faults do not produce such scarps; for generally denudation keeps pace with the dislocation, in which case there is no sign of the fracture at the surface. Such examples are frequent in the illustrations on the map of the Dorsetshire coast, to be studied in Section XXXVI (see Plates XIIIA and XIVB).

The Pass of Brander.—Fractures form lines of weakness, along which denudation finds work easy. On the Oban Sheet Loch Awe now drains from the northern end through the Pass of Brander instead of along a clearly marked valley at its southern end, its former course. The Pass of Brander is the work of an ancient overflow glacier and of the present river along a fracture line, which is continued through the middle reach of Loch Etive to Gleann Salach. Glen Tilt, on the Kingussie Sheet, is another such example; a view is given on Plate IIIB.

Atlas Examples.—Topographically the most important aspects of fault-scarps are the cases where they limit crust blocks, basins, and rift-valleys. The Cevennes wall separates the Central Plateau of France from the trench of the Lower Rhône, while the Rivers Allier and Loire in the northern section of the Central Plateau are flowing through fractured valleys. Fault-scarps limit the Bohemian Block and the rift-valley of the Middle Rhine between the Vosges and Black Forest. The Great Rift Valley of Africa and the Torrens Rift Valley in South Australia are other examples. The southern wall of the central backbone of New Guinea, 12,000 feet high, is said to be a stupendous fault-scarp. The Rocky Mountain

Trench, which extends from Flathead Lake to Alaska and contains the Upper Columbia, Upper Fraser and other lengthwise rivers, is fractured on its eastern side. Fractures and dislocation mark out the limits of some countries and continents, *e.g.* the west coast of Italy or of Arabia, and parts of the coasts of New Zealand.

PART IV

LAND-FORMS AND LIFE

SECTION XXII

THE HUMAN IMPRINT—THE "SIX ESSENTIALS"

ORDNANCE SURVEY SYMBOLS

As when a man that sails in a balloon,
  Down-looking sees the solid shining ground
Stream from beneath him in the broad blue noon,
  Tilth, hamlet, mead and mound.
    TENNYSON : *Dream of Fair Women* (Earlier Version).

The Essential Facts of Material Civilisation.—" Suppose," said the late Professor Jean Brunhes, " we rise in a balloon or aeroplane some hundreds of yards above the ground and note the essential facts of human geography, what is it we see ? Or, better still, what are the human facts that a photographic plate would register ? "

The first he gives is " men themselves," an answer of perhaps questionable truth under the conditions laid down. His " large blots of living humanity " might appear on a football ground when a cup-tie was in process of decision, but the " crowded deltas of the Orient " or " the most thickly populated districts of the Occident," their towns perhaps excepted, would appear from the altitude of a thousand feet almost as devoid of human beings as the blank spaces of the Siberian Tundra, the Saharan Hammadas or the Selvas of the Amazon. But it is with his second answer that we are more immediately concerned ; the " superficial excrescence," be it shelter, hut or house, which marks the abode of man, would certainly appear, and with it the road, the " line of passage sacrificed to movement," track, street or railway, diked river or canal. These two, the house and the road, closely

associated all the world over, he calls the two essential "facts of the unproductive use of the land."

Near most of the dwellings and along some of the roads still other spots, a third and fourth series of facts, appear and impress their images on the photographic plate. The camera that looked down upon Avebury (Plate XI) recorded not only the first pair of facts, houses and roads, but the clean strips of newly ploughed land, the dark patches of growing crops, belts of planted trees and cottage gardens. Fields and gardens testify to man's mastery over the soil and the plant-world through the tools which his brain and hand have made. Elsewhere, but still closely associated with men, the camera recorded flocks and herds—flocks of sheep hurdled and being fed off roots on the land and dairy cattle feeding in the pastures. These two—cultivated fields and domesticated animals—related closely both to physical conditions of soils and climate and to human needs for food and clothing, are the third and fourth essentials. They represent Man's conquest of plant and animal life, the facts of "the productive use of the land."

As the observer and his camera travel across the surface, new signs become prominent, the fifth and sixth essential marks on the picture of Man's use, or misuse, of his surroundings. The earth shows unhealable wounds, the white of lime-works in the North Downs, the grey of slate quarries in North Wales, the shafts, tip-heaps and smoke pall of the Black Country, where Man is taking out without replacing. The Americans call it "robber industry," the Germans "economic plunder." The sixth and last type is called devastation, "often brutal and violent, almost always short and quick, always decisive and final"—the reckless destruction of forests and the annihilation of men and things by war, the depletion of uncontrolled fisheries and the extinction of birds and beasts. These are the "facts of destructive economy," death-dealing, not life-giving.

These six sets of facts, arranged in three pairs, Brunhes selected as the essentials of human geography, and, since we shall recur to them more than once in the sections that follow, we will, for greater clearness, tabulate them.

I.—*Unproductive use of the Land*
(*a*) Houses. (*b*) Roads.

II.—*Plant and Animal Conquest*
(*a*) Cultivated fields. (*b*) Domesticated animals.

III.—*Destructive Economy*
(*a*) Exploitation of minerals. (*b*) Extermination of life.

These do not, of course, represent all the facts. Round and about them, whether visible or not to Brunhes' observer in the skies, lie other facts of another kind, Man's tools, which form, as it were, "his indispensable retinue." And again, there is a world "beyond the essential facts," a world of economic, social and political relationships. But the "Essential Six" represent the visible expression of the material aspects of civilisation.

The Map as a Photograph.—How far does the Ordnance Survey map match a print from the negative? The conventional signs, printed in the margin of each sheet, or, better, on the "Characteristic Sheet," should be examined; they give facts. Sometimes additional facts and relationships may be guardedly inferred from the map itself, as will appear in the studies that follow.

Brunhes' first set of facts—buildings—are well represented. The map sets out their distribution, thickly spread, say, over the Vale of Trent, thinly scattered in the Scottish Highlands, concentrated in the Chalk Country,

dispersed in the clay vales. Their sites and localisation can be discerned, the relationship to the physical facts of sun and shelter, of the upper and lower limits of permanent occupation, and to the human facts of routes and perhaps of activities. If little or nothing can be said of the materials of construction, something can be detected as to their form. The clustered settlement probably tells a story of relationships different from those of the village strung out along a road; the cathedral, castle and mansion are distinguishable from the church, manor and smithy of the countryside; sometimes even the dwelling can be distinguished from the workshop and the barn. Size, too, is not ignored; settlements are graded in greater detail by the type employed, from towns of over 300,000 inhabitants down to the hamlet of under 300. Associated public and private works appear: water-works, aqueducts and wind-pumps. Naval and military establishments and fortifications are recognisable by signs or print.

The second set of facts, too, is given in detail, the facts of the road, of "circulation," as the French term it. Roads are classified according to surface, width, and suitability to fast and other classes of traffic. Indication of a gradient steeper than 1 in 7 is given. Distinction is drawn between fenced and unfenced roads, which may offer suggestions as to the kind of country traversed; and the type of road and the closeness of its network suggest some activities and exclude others. Minor and private roads are left uncoloured. Information is given of toll bars and toll gates. Bridle paths and footpaths are not omitted. Railways are double, single and mineral, with associated principal and local stations, cuttings and embankments, bridges and other surface works. They often are suggestive, not only of contacts, but of the importance of a region, and they can reinforce evidence derived from other signs. Of waterways, canals are in blue, sometimes confusable with rivers, generally distinguishable by winding for long distances along a given

contour. Ferries for foot-passengers and for vehicles are differentiated on the Liverpool and other sheets. Sea-routes are sometimes drawn, and their importance may be inferred from dock and other accommodation or from their situation. Sometimes a name may suggest the type of cargo. Something of the ease, difficulty or importance of a channel can be read from lightships, buoys and beacons, as well as from submarine contours. Brunhes' first pair of facts then, the house and the road, appears in detail.

Of the second pair of facts, Man's conquest of plant and animal life, cultivated fields and domesticated animals, there is little record, though a few inferences are possible.[1] Parks and orchards are distinguished from copses and woodland; and the rough moorland pasture, which feeds Dartmoor ponies, Highland cattle or Fell sheep, has its sign. For the rest, tentative inferences must be derived from other sources. Main roads are of little help; they can indicate regional market-towns, but their relationship is generally to factors outside the district. A close net-work of lower class roads and lanes, however, brings thoughts of a close settlement, local life, long established cultivation of fields and pastures, and the intensive utilisation of the land. The presence of windmills, whether active or "old," or of mills beside streams, as on the sheet used for the Trent, would reinforce the suggestion offered by the roads, and perhaps tell something besides of the changed conditions that the Industrial Revolution has brought upon English farming.

Elsewhere, on open uplands, the prehistoric hill-top camp and cattle-pen stand up, united to their neighbours by grassy ridgeways along the even crests, but now deserted. Below, a line of village settlements marks the springs

[1] Reference should not be omitted to *The Land Utilisation Survey of Britain*. This new organisation (under the Presidency of Dr L. D. Stamp and with its headquarters at the London School of Economics) aims to map the classified use of the land over the whole country within a short space of time.

that issue from the lower slopes. We picture men and settlements migrating downhill, as peace was established, forests cleared and marshes drained. The priory, set in the vales, suggests the leadership in such peaceful development, as the castle, set on a slope or crowning a hill, throws the mind back to the disturbed times which retarded such progress.

The adequacy of the representation of Brunhes' third pair of facts, destructive economy and devastation, lies between the two—neither so full as for the unproductive use of the land, nor so scanty as for its productive use. Collieries, iron mines, used and disused lead mines are marked, and their unsightly tip-heaps are implied. Quarries for building stone and chalk pits for lime and cement are scattered over limestone regions. Of the destruction of forests information is only indirect, to be gathered from surviving patches of woodland or from names like Chute Forest and the Weald over a district now largely deforested. Such, however, is no certain sign; for the name is applied, for instance, in the Scottish Highlands, to regions which may never have been forest-covered.

Whether the "six essential facts" are sufficiently complete or not as the basis of human geography, at any rate they offer a clear-cut picture of the material side of life sufficient for our immediate purpose. If the map fails to record much that would be shown on the supposed photographic print, it makes amends by supplying much additional information, of which a few pieces have already been developed. The characteristics of every region are affected by its evolution in time, and in this respect the Ordnance Survey map may suggest broad outlines. A study of the place-names may give some chapter headings in the historical record—Celtic, Roman, Saxon, Danish, Norman—and may suggest that we watch for characteristics handed down from each people. One component in a village name not infrequently indicates the natural plant-cover at the time of settlement, and so enables us to

visualise something of betterment or devastation. The long, straight stretch of road that is aligned direct from point to point, that ignores differences of relief and leaves villages half a mile or more aside, reminds us of the Roman engineer and the marching legions that disciplined Britain.

On the photograph parish boundaries would appear only here and there—perhaps a line of stones or of mounds of earth. Although the sheets of the Popular Edition preserve county boundaries and omit those of the parish, the latter are represented on the Coloured Edition by lines of dots (not to be confused with the broken line of dashes which represent a footpath). They appear also on the old engraved sheets, and an index diagram of each county, showing the parishes, can be bought at the modest price of twopence. Here we see the old manor in the modern parish, usually manor and parish coincident but sometimes two manors combined in one parish or one manor divided.

Reference.—J. Brunhes: *Human Geography* (translated by T. C. Compte, and published by Harrap).

SECTION XXIII

VALLEY-SEEKING SETTLEMENTS—RURAL HAMLETS

CUMBRIAN SHEPHERDS

Come down, O maid, from yonder mountain height:
What pleasure lives in height (the shepherd sang),
In height and cold, the splendour of the hills?
TENNYSON: *The Princess.*

The Map and the District Selected.—As for Section XIX, Cumberland.

General Description.—We will consider life here under the six essential facts of the last section and then feel free in subsequent studies to treat some aspects only.

The human adjustments to the physical conditions of radial ridge and furrow are exceptionally clear. It must be borne in mind that the dome is a rain-drenched highland, so that our hypothetical photographic print, like the illustrations of Watendlath, Thirlmere and Rosthwaite (Plates XII, IX, X) would point to rough, open pasture on the mountains and small fields on the valley floors and delta flats. Life in the dome is based fundamentally on the pastoral mountains. On the surrounding frame the deeper soils and drier climate of the Eden and Carlisle Lowlands invite the agricultural economy in which the greater number of the people there are engaged; the great number of dispersed farms and villages and the intricate net of country roads and lanes confirm this. It is man's productive use of the rich, red soils. The west coast lowland of carboniferous rocks contrasts with both. Three

considerable towns show up at once: Maryport, Workington, Whitehaven, blotches too big and too close together to be related only to the agricultural life of the plain. Examination of the map finds harbours and docks, collieries and iron-works, "a seaward fringe of smoke and tip-heaps," in part the Destructive Economy of Professor Brunhes; but the towns offer, no doubt, a valuable market to the neighbouring agricultural population.

Watendlath.—But it is with the ridges and furrows, the fells and dales of the Dome, that we are primarily concerned. What of the first "essential fact," the house—its materials, site and grouping? The photograph of Watendlath (Plate XIIA) is typical of the older buildings. The stone seems derived from the rock on which it rests; roofs are of local slate; the colour of barns, shelters and dry stone walls is that of the mountain background. Only the farmhouses and cottages are whitewashed. The whole group tones in with the landscape.

Set high in altitude, nearly 900 feet, and at the foot of the tarn, the two homesteads seek shelter on the floor of their hanging valley. Isolated and alone, the hamlet must be almost self-supporting in winter. The large number of barns and outbuildings not only hold implements and stock, but store food for man and beast, and are ready for emergencies at lambing time. A rough road runs (to the left in the photograph) towards the market-town of Keswick; steep tracks on the near and far sides of the beck lead over the fells to Rosthwaite and Thirlmere. Much of this the map tells us, and the photograph confirms.

Valley Settlements.—If we were to climb from Watendlath and look down from Brund Fell or take a survey from an aeroplane, what does our map-print of Borrowdale and its two branches suggest that we should see of human settlement? The answer seems clear—a number of small hamlets strung out like a knotted string along the floor

of the dale and its two branches. High Lodore and Grange lie below the narrow neck at Brund and Grange Fell. Rosthwaite is set at the edge of the flats of an ancient lake-basin. Borrowdale is just below the junction of the branches, with Seatoller, Thornythwaite and Stonethwaite just above; and their church stands alone, or more probably beside vicarage and school, central for the four. Seathwaite lies a mile higher up the Derwent Valley. It seems a dispersed type of settlement in small groups, to which shelter counts as of primary importance, shelter particularly from the east.

If we now cross from the head of the eastern branch valley into Langdale, which lies east and west and leads to the head of Windermere, we see the same valley-seeking people, the same knotted-string type of settlement.

The feature of Lakeland settlement seems, then, related primarily to shelter and ease of communications, apparently seeking more particularly protection from the east in north-south valleys, sun-facing in those that lie east and west. We may think of them, and especially the more remote, in harmony with their physical setting, like Watendlath. The photograph of the Rosthwaite Basin and its hamlet (Plate XB) repeats the picture of a Watendlath on a more generous scale. The view looks north-east, as a comparison with the map will show. The walled pasture fields (but here with some sign of cultivation) and the village under the eastern fells occupy the foreground. The Derwent Valley enters from the right (north-east), Langstrath from the extreme left (north-west). Borrowdale church, vicarage and school are grouped together at the junction. A stream, marked but unnamed on the map, descends steeply in the middle of the picture from its hanging valley above, and there seem signs of a fan-shaped cone of debris over the left side of which the gill is now running.

Radial Pattern Distribution.—So we may see behind the

map a plan of narrow threads of settlement as radial as the divergent valleys, a spoke-like arrangement of valley-seeking dalesmen in sharp contrast to the wide extent of empty fell. The dalesmen meet the farmers of the agri-

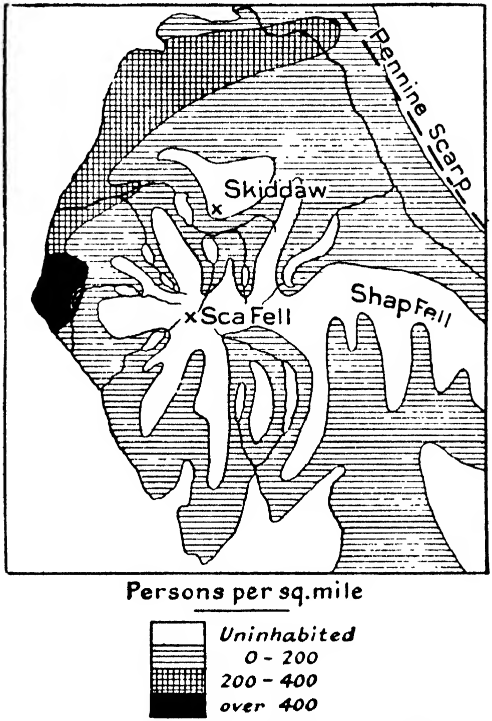

FIG. 31.—CUMBRIA—DENSITY OF POPULATION

cultural rim in a circle of small market towns at the valley outlets; the names of these, from Penrith clockwise round to Cockermouth, can be read from the map.

Density would show a concentric arrangement, increasing from the centre outwards. The central fell parishes can show only 25 persons or less to the square mile; the

marginal parishes rise to 50, and those on the lowlands have something in the neighbourhood of 75 and over.

The Road.—The presence of a road is determined by human needs; its route is guided by physical relief. Roads came late into highland regions; for it must be remembered that the English road-system, unlike those of France and Germany, was built piece-meal and by private enterprise, where the amount of traffic justified it. Among the Lake Mountains the pack-pony long remained the chief carrier, and narrow, arched bridges, the width of which can take no wheeled vehicle, are still to be seen; one appears on the view of Watendlath (Plate XIIA). Although each valley has its own local road, of low classification but sufficient for its needs, the interior massifs round Scafell Pike and Shap Fell have in the past imposed dale-head limits for anything except pony tracks. There is, as yet, no central gathering point to bind the separate units into a single system. General opposition to threatened motoring roads has preserved the natural amenities of its untouched wildness, and it is good to know that under the National Trust some of its area will preserve the peace of its remoteness and the beauty of its scenery as a National Park.

East of the centre only, long trenches from Coniston Water and Windermere in the south to Derwentwater and Ullswater in the north carry thoroughfares past Dunmail Raise or over the Kirkstone Pass, joining lakeland markets and tourist bases—Keswick, Ambleside and Windermere—both with each other and with the main approaches from without. Provision for lovers of scenic beauty is the second great industry of Lakeland, and herein lies one of its two functions in the life of England. The other external function is the provision of water, already from Thirlmere and soon from Hawes Water, for Manchester and the great industrial masses of Northern England.

Productive Occupation of the Land—cultivated fields and domesticated animals. Realising the steep relief and high rainfall, we may well believe that life is pastoral—homes in the dales, work on the fells. The silver-faced Herdwick to the west and the black-faced, horned Fell sheep of the east are the sheet-anchor of lakeland farms. On the valley floors and deltaic flats dairying has some hold in connection with the tourist centres within and the industrial towns without. The amount of cultivated land is stated to be only 2 per cent. in the central parishes but increases outwards to 40 per cent. and more on the lowlands with crops that are least resentful of cloud and rain. But of all this the map gives no sign, nor of old artistic associations and the tradition of craftsmanship revived in village industries, spinning and weaving, metal and wood-working.

Destructive Economy.—The half-inch map here used necessarily omits some of the information that is given on larger scales, and a search has revealed few cases of "robber industry," once more widespread than now. On the western slopes of the Derwent Valley above Borrowdale is marked the Wad mine, now disused, but once helping to provide Keswick with the graphite for its pencil industry. The quarries of thick, green slates, which are marked above the head of the Buttermere Valley, are one example of a regional industry and provide the building material that characterises lakeland cottages, barns and roofs, already referred to in describing the illustrations of Watendlath and Rosthwaite.

The place-names are full of meaning, both descriptive and historical. Gill (a small mountain-stream) and force (fos, a waterfall, as in Scale Force) are Norse in origin. These however do not tell of colonisation. It is otherwise with -thwaite (a piece cut out, sometimes a forest clearing); this suffix not only gives a record of probable forest destruction, but distinguishes Norwegian settlement from

Danish, for which the distinctive ending is -thorpe. Thwaite appears on the map four times in Borrowdale, nine times between Keswick and the foot of Bassenthwaite Lake, five times between the foot of Crummock Water and Cockermouth. It occurs too in Douthwaitehead, a mile north-west of Ullswater, at the head of the lower step in the glaciated Aira Beck Valley; this seems the highest hamlet in Lakeland (1250 feet). Norse seamen, who came down the west coast of Britain, entered the Lake District in the tenth century. On the surrounding lowlands it may be noted that -ton is frequent, suggestive of Anglo-Saxon encirclement.

Other Large Scale and Atlas Illustrations.—Since human facts, apart from towns and roads, are less well represented on maps than physical conditions, it is not easy to offer illustrations for comparison. But fingers and bands of human distribution with associated patterns of roads and railways may be gathered here and there—the map of the distribution of population in Bartholomew's Atlas of England and Wales and in that of Scotland should afford some examples. For instance, fingers of pastoral settlement, as in the Lake District, spread up the valleys of Wales from the Cardigan Coast or up the valleys that are tributary to Tweed-dale.

In Southern Ireland bands of higher density and espalier- or grid-pattern railway systems fit into the parallel troughs. The ridges of Old Red Sandstone are mainly barren, rocky wastes, which rise westwards into the massive bastions and scarped cirques of Macgillicuddy's Reeks. The valley floors, carpeted with surviving limestone, are contrastedly rich, containing some of the " sweetest soyle of Ireland." Moistened by ample rains, kept emerald green by the mildness of winter temperatures and settled by a cattle-loving people, these troughs are the background of the stock-breeding, dairying and dependent industries, which are epitomised in the life of Cork, the " capital of Irish

Ireland." In Munster one-fifth is barren mountain, heath and bog; one-fifth is under crops, largely clovers in peasant holdings; three-fifths are under grass. Folded regions are barriers to movement, especially crosswise. Transverse gaps usually pass through one ridge only; hence routes are frequently zigzag, as from Cork to Bantry. But here in Southern Ireland the rivers penetrate often in direct line across the whole belt, as between Mallow and Cork in the famous Mallow gap. Routes then are grid-pattern in young folded regions, lengthwise along the downfolds, transverse through gaps in the ridges. The Mallow gap (under 450 feet) links the capital not only with the remote south-west, but with the Atlantic beyond through the outport of Queenstown (Kobh). Market-towns are aligned along the furrows, with junctions at some of the gap nodal points.

Reference.—An essay on *Cumbria* by F. J. Campbell, published by the Cambridge University Press, might well be read by all senior students as a model of concise and lucid geographical treatment.

SECTION XXIV

VALLEY-SEEKING SETTLEMENT—TERRACED TOWNS

MONMOUTHSHIRE MINERS

He putteth forth his hand upon the flinty rock;
He overturneth mountains by the roots.
He cutteth out channels among the rocks
And his eye seeth every precious thing.
He bindeth the streams that they trickle not
And the thing that is hid bringeth forth to light.

The Book of Job.

The Map and the District Selected.—As for Section VI, Newport and District.

General Description.—The chief physical features, as described in Section VI, are the narrow, steep-sided valleys, which are sunk deeply into a barren mountain land; their direction is from north-north-west to south-south-east. As with the Lake District, a valley-seeking people is to be expected; and on them the depth and the direction of the valleys have important results, both economic and social.

Valley Settlements.—The characteristic human grouping of the Lake District was seen to be the isolated farm and the extended line of rural hamlets. This map shows the population of West Monmouthshire to be dense and urban. While some towns, like Treharris (E, 1) and Bargoed (D, 3), have developed at valley junctions, no such cause for growth can be assigned to others, like Rhymney (B, 2) and Abertillery (C, 5). An examination of the valleys of the

two Ebbws discloses almost continuous ribbons of settlement for several miles. The presence of minerals at once suggests itself, and the suggestion becomes the certainty of a "fact of destructive economy," when a further scrutiny reveals the number of collieries, iron-works and steel-works marked in the upper parts of the Ebbw and other valleys. Mineral lines can be seen on the map to lead down from the pit-heads to the main railways on the valley floors below.

Coal.—Of the three great occupations of West Monmouthshire—mining, metal-working and transport—coal mining stands out pre-eminent. It is the key industry and is almost the sole occupation of the men, except in Ebbw Vale and Tredegar, where iron and steel works are marked beside collieries. Coal is the basis, not only of the metal industries, which are now mainly centred round Swansea, but also of those which survive in these inland towns. It is the source, too, of the export from Cardiff and Newport, on which the valleys converge. As an article of export, it provides a direct livelihood for large numbers of workers on the railways and at the docks. In addition, it has indirect effects of immense national importance in reducing the transport costs of inward-bound food and raw materials by providing outward-bound cargoes.

The coal-field of South Wales is unlike any other in Britain in several ways. First, the strata are more disturbed, fractured and dislocated than elsewhere. Secondly, it lies in a mountain land, whereas the others are in more open country or concealed under a thick mantle of later deposits. Thirdly, it stands pre-eminent by reason of the high quality and great variety of the coal. Its steam coal is the best in the world, *e.g.* for bunkering; the hardness of its bituminous coal will stand any climate; its anthracite has no rival except in Pennsylvania. No wonder "Coal is King."

The metal industries are proved by the map to be

localised on the northern fringe. Here, on the outcrop of the structural basin, ironstone is associated with coal, limestone and furnace-sandstone, all the physical foundations of blast-furnace work. But the opening of richer iron mines elsewhere, *e.g.* in Cumberland and Spain, led to a migration of a large part of the metallurgical industries to the seaboard round Swansea, their present focus. Coal therefore remains the fundamental fact in the valleys of West Monmouthshire. There are some 50,000 miners, as against less than 15,000 metal-workers, and, although the adoption of better methods shows signs of reducing the number, they will still exceed the metal-workers.

The Roads.—Each valley has its main road and railway, one at least of each, sometimes two. This close-set grid-pattern of lines implies heavy traffic with the outside world. The plan of the valleys (Fig. 13, p. 38) shows how they converge, seven on Cardiff, five on Newport. In normal times we might picture an unending succession of coal trains going down, chiefly to the dock-side coal-hoists, but also to metallurgical works at the seaboard, and returning loaded with pit props from Canada or the Baltic and domestic necessaries from overseas farms. The frequency of the stations—at an average distance of a mile and a half apart in the Rhymney and Sirhowy Valleys—adds further testimony of an intense activity and crowded life.

Social Conditions.—The social life, as well as the economic, is conditioned at every turn by the physical features of the district. Although the depths to which the rivers have trenched have enabled access to many of the coal seams by adit, in other ways the steep, narrow valleys are profoundly harmful. The people are densely packed together. The towns have to climb up the steep slopes with streets drawn out along their lengths. The houses run in monotonous terraces, tier above tier, instead

of converging, star-like, on a common centre. Central public buildings are absent. Such an arrangement is disclosed by the map, if one compares the forms of the larger Tredegar (A, 2) in the Sirhowy Valley, Blaina (A, 4) in the valley of the Ebbw Fach, and the town of Ebbw Vale. The absence of a central focus hinders the natural growth of a civic feeling, as the general absence of roads across the barren intervening moorlands hinders that of a common regional tie between the valleys.

The above hampering conditions were all emphasised by a Commission of Enquiry into Industrial Unrest. Its report goes still further and points out, as might perhaps be deduced from the map, that the aspect and surroundings of many miners' houses rendered them injurious. Owing to the lie of the valleys, many dwellings built on the south-west side face north-east and are sunless; their backs face a mountain wall. On the north-east side, although the fronts face the afternoon sun, the backs face a mountain wall or an unsightly tip-heap. Moreover, dwellings, works and tip-heaps are often mingled together. All this means, as the report explains, an individual and collective burden of ill-health, predisposition to fatigue and general reduction of efficiency; it cannot but affect for the worse the whole outlook of man, woman and child.

The steep slopes raise the cost of living by raising the cost of building and road-making; and the upkeep of mains for water, gas and drainage is rendered expensive owing to land-slides. Moreover, the lack of soil and level spaces for gardens and allotments, for playgrounds and recreation, not only adds still more to the cost of living, but deprives all of a healthy employment in leisure hours.

Something of all this can be seen on the illustration (Plate IB) of Bargoed (left) and Aber-bargoed (right). Monotonous rows of houses, backyards and ugly streets rise one above the other up the hillside, although the valley opens out here. Windows look out over a dreary waste of railway lines, coal trucks, gas-works and chim-

neys, or else a niggardly countryside. There does not seem a building worthy of admiration, and the only common focus is the railway station.

The general result has been a lack of variety of occupation—" Once a miner, always a miner,"—so that a falling off of exports creates widespread distress owing to the dangerous economic dependence on a single product. The lack of that widened outlook which free intercourse gives encourages an exaggerated idea of the importance of the one product, coal. Antagonism to existing conditions and a general feeling of unrest result, not lessened by managers who may find it hard to understand the Welshman. Nor are the difficulties diminished by the large immigration of young men from the English Lowland, who are not always sympathetic towards a temperament and outlook different from their own.

Reference.—*Commission of Enquiry into Industrial Unrest, Report for Wales, including Monmouthshire* (H.M. Stationery Office, 1917).

SECTION XXV

HILL-SEEKING SETTLEMENT—CAMPS, CASTLES AND HOMES

FLINT MEN

Of old sat Freedom on the heights.
TENNYSON.

The Map and the District Selected.—Lincoln, Maidstone and Vesuvius,—Sheets as for Sections XIV, XVII and XX.

General Description.—The hill-top settlement spells greater security and implies an age of disturbed conditions. The lowland site attracts in more peaceful times by the value of shelter, the proximity of water, the richness of soils and the ease of movement. On the other hand, the lure of health or the full and complete mastery of a varied natural environment may lead men permanently or temporarily upwards.

Southern Italy.—To find the hill-top town and village a normal feature of the landscape to-day one must needs go to more southern lands. The Mediterranean early developed the urban type of life. In an age when pillage was a means of livelihood as well as a pastime, the hill-top or rocky eminence offered security, which was strengthened by compact human grouping. And the high position was a further safeguard against the mosquito of lowland swamps. So by tradition, as well as by reasons of health, South Italian settlements, for instance, with

associated roads, line the backs of the ridges, while the malarial valleys, almost devoid of dwellings, are left to fields and to modern railway routes.

The only map of Italy in this series is that of Vesuvius. It may perhaps be considered here without confusion. Settlement has occupied the lowlands. The first glance at the map reveals a ring of towns and villages encircling the cone. Closer inspection shows them set on the lower slopes, between 300 and 600 feet above the sea, where presumably water is accessible. They are linked by a double girdle of road and railway. Settlement has spread up the flanks of the cone; dwellings, though scattered, are many. The lavas must have decayed into fine soils of high fertility up to and above 1000 feet. On the north side tree growth extends still higher to the edge of the ancient crater, Monte Somma; the upper slopes on the west and south seem bare, probably because recent volcanic activities, judged by the dates given to the lava flows, are confined to these sides, and the rock has not yet had time to form a superficial soil. We may then picture rising bands of cultivation up to 1000 feet, orange groves, olive orchards and vineyards, in ascending order. A similar distribution of people, gardens and roads char acterises Mt. Etna in Sicily.

Across the centre of the map from north to south, from Aversa to Naples, the Campanian Plain has been firmly occupied. The number and closeness of the towns and villages give a clue to the richness of the soils here. The compact urban grouping is a characteristic trait in Italy; traditionally the Italian lives in the village and goes out daily to his farm, often over long distances. It will be noted that there are few buildings marked in the intervening spaces.

To east and west, however, buildings are scattered and separate. The flatness of the country and the wetness suggested either by drainage channels or by nearness to a lagoon coast would postpone occupation and make one

think of marsh and malaria, of the drainage engineer and recent colonisation.

Scotland.—In the disturbed borderlands and lowlands of Scotland and Wales castle-crowned spurs and crags, often moated by river-loops, are not uncommon. Edinburgh owes its site to a volcanic stump, a forward defensive point to guard the east coast entry into the Central Lowlands against England, the old enemy. Dunbar, Dumbarton and Stirling are other names familiar in the stormy history of Scotland.

In England, the history of which has been characterised by relatively quicker and more peaceful development, the earliest examples of hill-top settlements are the prehistoric camps on the crests of the chalk downs and other dry, open moorlands. But examples of these may be postponed to sections following, when the population distribution in this type of country is considered. Meantime we need only note that the Roman garrisons, in what was an alien land, chose hill-sites at strategic points. Lincoln (Lindum Colonia) is one such example, and the map shows that those who followed did not neglect the same advantage on the slope of the Witham Gap. Castle and Cathedral are set at the top of " Steep Street," while market and manufacturing Lincoln lies below.

Reference is made later to the value of gravelly or rocky islands amid marshlands. But four well-known instances may be added here. Seven knobs of volcanic rock among the marshes of the Tiber offered a site for the foundation of Rome. The Isle of Ely, an upstanding boss of Lower Greensand, is a landmark for miles in the Cambridgeshire Fenland. Jerusalem and the Acropolis of Athens are equally famous examples of the natural security provided by summits.

Modern Uphill Movement.—In all times and in all

countries, as peace develops, men have tended to move downhill in search of water and soils, of shelter and freedom of movement. But in modern times, when water can be lifted to the heights, when metalled roads and mechanical means of transport penetrate high and low land alike, men, and perhaps especially the well-to-do, are reversing the direction and seeking homes uphill again. The beneficent effects of health-giving sunshine and invigorating air above the damp and fog outweigh the value of the shelter afforded by low-lying sites. Such ascent is further encouraged, when the soils of the heights are unfit for cultivation. The suburban dormitory of Sevenoaks, with its neighbouring wooded sands on the Ragstone Ridge, is merely one example of that attraction of altitude for residence, which is visible in most parts of England. The low-lying Thames marshes are the last districts to be built over under the pressure of a rapidly expanding population.

The classical, but not the only, example of uphill summer migration comes from Switzerland, where on the grassy ledges above the winter village the peasant sets his temporary summer hamlet and exploits the pastures of the Alps.

FLOOD-SHUNNING SETTLEMENT—FENS AND FLOOD-PLAINS

RHÔNE MAS AND MARSHMEN

There the Rhône, with bosom quiet,
Slumbered after all his riot,
Dreaming still of Avignon, her papal majesty,
Dance, and mirth, and music, sighing
Now for all behind him lying,
Now, like some old hero dying,
That so soon he must surrender name and waters to the sea.

MISTRAL : *Mireio* (Georgian Translations).

The Map and the District Selected.—As for Section IX, the Rhône Delta.

General Description.—The marshy levels and fens of the Rhône and Durance Deltas thrust themselves forward from Arles and the Land of the Troubadours ; they divide the narrow strip of the Midi, separating the monotonous sand-bars and lagoons of the west from the rocky shores of the east. The Petit Branch of the Rhône has long formed a political, as well as a physical, boundary between Provence and Languedoc. Arles, the guardian of the bridge, not only binds together the three regions of Provence—the irrigated gardens of the Lower Rhône Valley, the pastoral solitudes of the deltaic fens and the sheltered rocky coves of the Maritime Riviera—but links the two departments.

We have to remember that here we are in a country very different from our own. Rocky, limestone hills, with stony soils, stand up in the clear air with sharply cut

outlines between the deep blues of sky and sea. Each summer, sun and drought parch the land. The violent mistral sweeps over the flats, withering in summer, freezing in winter. The hard, evergreen bushes on a tufted carpet are dull of hue.

In the physical study of the Rhône Delta (Section IX) we divided the map into three divisions from west to east: (*a*) the coast sand-bars and lagoons of Languedoc from Cette to Aigues-Mortes, (*b*) Ile de la Camargue, (*c*) La Crau, and the same divisions will serve in these studies of human adjustments.

The Vineyard of Languedoc.—The west displays three descending bands in reaching the regular curve of the false shore spread out in front of what was once a coast like the present Riviera. The hilly background is covered with woodland, *maquis* and *garrigue*. The second, terraced, step is an almost continuous vineyard, of which the map gives no sign, except in the number of villages, roads and railways that stamp the prosperity of the district on either side of Montpellier. The vine is spreading on to the lowest step, following the reclamation of the soils of the lagoons, *e.g.* round the Vidourles and Aigues-Mortes. Languedoc to-day is dangerously dependent on a single product.

The canals and salt-pans of some of the lagoons indicate activities of a different kind; and the road and railway connections of Cette and Palavas with the interior suggest that, if the forts and batteries *déclassées* are signs of changed conditions of defence which is now concentrated in the great naval station of Toulon, local fisheries, possibly for tunny and sardine, and maritime trade have not yet been entirely engulfed by Marseilles. Cette, indeed, placed on a " tied " rocky island, is a great wine port and has active exchanges with Algiers and the Atlas lands.

L'Ile de la Camargue is a very different region—of Rhône

mud, grey-green salt-marsh and sand-dune—where the mistral, the Masterful One, sweeps unhindered, and where malaria reigns. Droves of white horses and black cattle roam as free and wild as on the open ranges of the old Wild West. Myriads of water-fowl, *oiseaux pêcheurs*, frequent its waters—among them the Egyptian ibis and the pink-plumaged flamingo.

Yet not all is pasture. Reclamation is at work, and, although progress may not have advanced far, signs of the conquest of the marshlands are in evidence. Humble roads and light railways, with stations and *haltes* in the open wilderness, mean men and movement. Channels, marked in blue, are filled by steam-pumps and carry water from the river to keep the soil clear of salt, the scourge of the agricultural lands won from the marsh. The vine is following. Within the delta the map shows no town, only the lowest degree of the signs of settlement. Tiny hamlets or large rural properties (*château*, *mas*) are stretched along the narrow bands of slightly higher ground that line the two branches, and here too, only, are roads and railways found.

The impress of the violent mistral, piercingly cold in winter, scorching and dust-laden in summer, is widely evident there. "Tout se courbe devant lui. Les moindres arbustes gardent l'empreinte de son passage, en restant tordus, couchés vers le sud dans l'attitude d'une fuite perpetuelle." Farm-house and hut, *mas* and *cabane*, turn their windowless backs to its blasts and face the sun. Wind-breaks of dark green cypress and fences of reeds line the roads and canals or shelter dwellings and gardens. The *cabanes* too, built of reeds, dried and yellow, have rounded backs, like the *yurts* of the Asiatic steppe nomad, to throw off the violence of the wind. The sameness of life still matches the sameness of the simple environment; the men are men of the fields or men of the marshes, cattlemen and agricultural workers, or fishermen and basket-makers.

The towns of the delta are along its margins. Arles, like Cairo on the Nile, stands at the apex and not only unites valley and delta but guards the river crossing. Walled and battlemented Aigues-Mortes has sunk since the days of the Crusades and yielded place to Cette, notwithstanding the canalising effort of King Francis I in the sixteenth century to improve the channel (the *grau* of the map) as a navigable waterway. Port St. Louis is modern, unlike Aigues-Mortes. It has only the symbol for a large village; for it has suffered from proximity to Marseilles in spite of the canal which ends away from the unstable mouth direct to the deep and sheltered Golfe de Fos.

La Crau, so different in its dry stoniness from the sodden muds of the Camargue, likewise offers little on the map for evidence of settlement. Only in the north-west and north-east have the Canal de Craponne and others forced back the desert. By the nets of roads and irrigation channels, open though they still are, the map points to the beginnings of a conquest, which is reaching out from Arles and from Lamanon, eventually to unite in a continuous northern band. Neither the main road nor the double-lined railway, each of higher degree than any in the Camargue, can be related solely to local needs. In the heart of the plain villages and hamlets have not yet arisen; only great *mas*, in scattered oases created by irrigation, with the same form, orientation and shelters as in the Camargue, are shown. Sheep replace semi-wild cattle; for in winter transhumant flocks of sheep and goats from the heights of Savoy invade the Crau for its scanty pasture. On the rocky, limestone flanks, north and east, lines of village groupings repeat the case of Languedoc.

The whole region is full of "sign or token of some eldest nation"; for it was early Romanised. Provence indeed derives its name from the Romans, and memorials of the Imperial City are abundant. The aqueduct of Nîmes is just off the map. The central market dominated by the

hôtel de ville (forum and senate-house) is the pivot of the plan of Arles, as of near-by Avignon; later Christian influence had to be content, unlike the case of the more distant Paris Basin, with a cathedral pushed to one side. The ports of the delta flourished in the Middle Ages, when ships, laden with spices, sailed along the Rhône streams. But the concentration in the great oceanic port under modern conditions has withdrawn external contacts and left them only their traditions. Salon and Miramas, along the eastern fringe of La Crau, are as busy as Aigues-Mortes is dead; they share in the industries and distributive activities of Marseilles.

Other Large Scale Illustrations.—Equally with deltas, other lands that are water-logged or liable to flood are repellent. The Fens, it is true, are now dotted with farms, but on the wedge of the Lincoln Sheet dwellings mainly seek the margins. The alluvial flood-plain of the Ribble bears hardly a building, and that of the Trent none at all. The wet, spongy "Mosses" of South-west Lancashire, to be studied in the last section of the book, have until recently been left blank, partly because they offer no stable foundations, and partly because adequate slopes for sewerage are absent. In crowded districts, like the London area, the marshes are the last to be built over, and there is always the danger that drainage will cause the contraction of the soils and subsidence of foundations.

We have described in Section VIII how the Trent has laid down a wide belt of spongy alluvium amid the drier gravel sheet of earlier days. The distinctive lines, therefore, in this level land are the meeting edges of gravel and alluvium, the dry and the wet. They might be inferred from the two lines of villages that flank the river, from Dunham to Aversham on the west and from Newton upon Trent to Newark on the east, at intervals of rather more than a mile. The hachures of the Coloured Edition give an exaggerated idea of the fall of the ground; a

comparison of the spot-heights soon reveals that, although there are slopes, they are slight. Villages seem content with porous gravels as foundations. Some villages which might have chosen decided slopes have not done so; Sutton-on-Trent is not set on Barrel Hill, nor is South Clifton on Clifton Hill. Perhaps the importance of the river as a highway kept the settlement as close as possible.

Inter-village roads now match one another on the two sides of, but further from, the river, and the villages are attached to them by lengths of minor road. Some show a clustered grouping, like South Clifton and Kelham; others, like Besthorpe and Collingham, are stretched out in single or double lines along the border of the flood-plain.

Further from the river, over the gentle swells of the gravel lands, villages seem dotted at random; both groups and single farms cling to what slopes there are and avoid the wetter bottoms.

The agricultural nature of the country is clear enough, when we note that each village has its smithy and that the map is dotted with water-mills and windmills, though the "old" windmill, that appears so frequently, speaks of the passing of medieval self-sufficiency and the dependance upon imported wheat, which is ground at the great ports. Fruit-growing, which appears in the orchards to the west of the river, *e.g.* at Tuxford and East Markham, suggests efforts to vary the basis of economic life. The richness of the land is further confirmed by the close network of fenced roads. Many of the forest remnants and plantations seem preserved for sporting purposes, if the several "fox coverts" and the large number of parks and mansions may be taken to indicate here the hunting for which the midland shires are famous.

It is said that no country in the world possesses rural homes and villages which have the charm of our English cottages and hamlets. Other countries may show grander settings, but they cannot match the English countryside for quiet beauty and varied interest. No

two villages are alike, though all may have the traditional grouping beneath the shade of elms and under the protection of the church, around which the life of each has gathered. The marking on the map, at North Muskham, for instance, of hall, manor and farm, smithy, mill and inn reminds not only of rural activities, but of the social groupings that are or have been characteristic of the English countryside—landowner, tenant farmer and landless labourer.

The Vale of Trent seems to have been a desirable land, easily accessible to Anglo-Saxon immigrants and Danish traders from the east by the entries of the Humber and the Wash. Key Anglo-Saxon endings in place-names are -ham and -ton, meaning a settlement. Of the twenty-one villages that lie within a mile of the river here, no less than fifteen (nine -hams and six -tons) are of such origin. But other endings, like the Scandinavian -by, are also common ; we are in the midst of the Danelaw. There are said to be more than 600 towns and villages in Lincolnshire alone with this termination. Their frequency, especially east of the river towards Lincoln (see also the Lincoln Sheet) suggests the close hold that the Danes had upon this part of the country—Saxilby, Whisby, Thurlby, Harby, Swinderby, and others. The key component for Danish is -thorpe, as -thwaite of the Cumbrian map is for Norwegian. Thorpe occurs sixty times in Lincolnshire, only once in Cumberland ; here may be found Winthorpe, Besthorpe, Grassthorpe and Thorpe on the Hill.

Atlas Examples.—The Rhône Delta instances the characteristic distribution of men and their settlements in delta lands. Scanty and scattered in the delta itself until reclaimed, men are more thickly spread along the hard ground of its inner margin, where a climax of importance and numbers is reached at the apex of the delta. Sometimes small local ports grow at the ends of the distributaries, but these are eclipsed by a greater centre on the

nearest convenient bay away from silt-laden currents. Here and there the river or human enterprise makes possible a central focus, of which perhaps Calcutta and New Orleans are the chief examples, and then the outer ports do not arise. The student might well examine all the deltas mentioned in the example on page 57 and classify them by these human criteria, as far as his atlas allows.

Reference.—E. de Martonne, *Les Grandes Régions de la France: Région Méditerranéenne* (Paris, Payot). Senior students should read Alphonse Daudet's description of the Camargue in his *Lettres de Mon Moulin*. Frédéric Mistral's *Mireio, A Provençal Poem*, too, has much apt description.

SECTION XXVII

WATER-SEEKING SETTLEMENT—RIPARIAN HAMLETS

YORKSHIRE DALESMEN

And he had trudged through Yorkshire dales
Amid the rocks and winding scars,
Where deep and low the hamlets lie
Beneath their little patch of sky
And little lot of stars.

WORDSWORTH : *Peter Bell.*

The Map and the District Selected.—As for Section XV, Kirkby Lonsdale and Hawes Sheet.

General Description.—The significant factors have already been described in Section XV. A horizontal platform of Great Scar Limestone, 600 feet in thickness, bears on its back many isolated, tabular blocks, like Ingleborough, Whernside and Penyghent. The platform has been trenched by dales which dig deeply into the limestone and, in their lower courses, right through it into the impervious beds below; three such dales are included within the district selected—Kingsdale, Gretadale and Ribblesdale.

The limestone is pure and leaves little residue, but that a soil blanket is not everywhere missing is suggested by three names on the map: "mosses" or spongy peat bogs with cotton grass; "moors" or drier heather lands; and "pastures" of rough grazing. The "drifts" of the Ice Age and the weathering of the shales seem chiefly responsible.

A glance at the map is sufficient to reveal the general absence of signs of settlement except along the dales; fell sides and platforms are devoid of dwellings. The people are valley-seeking, as they were in the Lake Dome, in this wind-swept, treeless moorland. But, while in the Lake District springs are everywhere, surface water is abundant and upland farms and even hamlets are to be found, in the limestone of the Ingleborough region the water is out of reach underground and settlement therefore is essentially water-seeking, and permanent water coincides with the valley floors.

Kingsdale.—Of the three dales the simplest is Kingsdale; it is least disturbed by external influences. The most obvious fact is the apparent desolation of the steep valley sides, which, when correlated with the frequent hill pastures named on the map, suggests at once a pastoral, not an arable, land. At the same time, below Braida Garth Kingsdale Beck seems edged with a narrow ribbon of flood-plain. Below this point, too, the word "pastures" ceases and is replaced by Moss, Rigg and Scar. Perhaps then we are not likely to be far wrong in assuming from these facts that above Braida Garth the mainstay of farm life is the sheep on the rough fell pastures, while below the chief concern is with cattle, for which the dales are famous; Braida Garth, which the group of buildings marked would show to be a farm of considerable size, is probably concerned with both.

All these suggestions, which the map offers, are strengthened by the general absence of dwellings. Besides Braida Garth Kingsdale House appears to be the only other which has a road approach. The few scattered buildings without road approaches may be taken to be barns or animal shelters. The third-class road, too, has some indications to give. Its low classification confirms the local life and absence of traffic; the fact, however, that it is marked as fenced, suggests that animals are in the fields. We may

note, too, that there is no hamlet, not even church, post office nor inn along the length of the dale.

Gretadale, the next valley to the south-east, presents similar features. It has, however, been more deeply trenched, 200 feet lower down into the impervious Silurian beds below. The contour lines show a clear division half way down the length of the dale; at Chapel le Dale there is a steep drop, and below it the valley suddenly widens. Above this point—that is, above 1000 feet—the Greta is constantly disappearing underground; in other words, down to this point the river is flowing over a limestone bed. Below, it is flowing over impervious rocks, and there is no more disappearance. A narrow flood-plain appears between walled fields of gentler, grassy slopes, above which rise, tier upon tier, rocky limestone scars. The photograph on Plate V shows these features well.

From the human point of view life is on a slightly larger scale than in Kingsdale. Groups of dwellings and barns, though still spaced out at wide intervals, are more frequent; side roads and tracks lead up the hill sides. We shall probably not be far wrong in reading from the map, as we did for Kingsdale, that the sheep-farm of the hill pastures predominates above Chapel le Dale, and the cattle-farm of the alluvial meadows below. The hamlet lies hinge-wise at the junction point of the upper and lower sections of the dale and shows, not only a large group of farm buildings, but a church, post office and inn.

A tramway, parallel to the road, beginning near Dale House and linking with the railway at Ingleton, suggests quarries or lime works, while coal mines marked postulate mineral activities in former days and link the rocks with the Carboniferous Period.

Ribblesdale, the third valley, is the largest of the three. Only the upper half appears on this map; for the Craven fault runs south-east, and this upper valley lies at 900 feet.

Similar features and similar deductions are possible here—scattered farms, dwellings and barns, but at more frequent intervals—roads, tracks and footpaths leading to the upper fell pastures, lime works and a second-class road. The double-line railway is clearly not related only to local traffic, but serves regions beyond ; it is, in fact, a section, the most desolate section, of the main line of the London, Midland and Scottish, where it crosses the Pennines from Leeds to Carlisle. Its course is helped by the fragmentary nature of the table-lands, though not without an immense brick viaduct, where it crosses from Ribblesdale to Upper Gretadale, and a mile-and-a-half long tunnel through Blea Moor.

Here in this valley are one hamlet, Selside, and one village, Horton, which is large enough to obtain a parish and a telegraph office of its own. The village lies up the mouth of a tributary valley which no doubt gives access to the fell pastures above ; the map is clear that the tributary valley is the work of a beck which "issues," full-bodied, at the base of the limestone ; and we may justifiably add a picture of houses, barns, church, bridges and walls, built of limestone and giving a prevailing tone of dull, monotonous grey. The winding walled road, lime-works and mineral line are found again here.

The whole is a hard land, physically and humanly speaking. It supports only scattered groups of shepherds, cattlemen and quarrymen.

Other Large Scale Illustrations of settlements in limestone regions will be found in Section XXVIII (Maidstone), XXIX (North Wiltshire), XXXVII (Zara), as well as on the Lincoln Sheet (p. 194).

SECTION XXVIII

WATER-SEEKING SETTLEMENT—SPRING-LINE VILLAGES

THE GARDEN OF ENGLAND

Far Kentish hop-fields round him seemed,
  Like dreams, to come and go;
Bright leagues of cherry-blossom gleamed,
  One sheet of living snow.

DOYLE: *The Private of the Buffs.*

The Map and the District Selected.—As for Section XVII, Maidstone District.

General Description.—William Marshall, writing in 1798, summed up the situation in Kent in the following words: "The inhabitants, according to situation from the Thames southward, distinguish Kent into three plots or portions—they call them degrees: the upper, lying upon the Thames, they look upon to be healthy, but not altogether so rich; the middle part to be healthy and rich; the lower to be rich, but withal unhealthy, because of the wet marshy soil in most parts of it." He (or the inhabitants) was visualising human well-being in the three lowland belts of the Thames Estuary, the Vale of Holmesdale and the Vale of the Low Weald. We have to complete the description by adding the three parallel upland bands of the chalk North Downs, the Ragstone Ridge of Lower Greensand and the Forest Ridge of Hastings and other Sandstones.

With so distinctive a structural framework and the river system of the Medway so delicately adjusted to it, the human reactions in the productive use of the land,

in its settlements and roads, should be correspondingly definite in a region of such long, slow, historical growth. Yet in a peninsula which not only has played an important rôle as a land-thoroughfare between the Continent and England, but also guards the water-approach to London along the Thames, there need be no surprise to find human adaptations to some extent modified and supplemented by the pull of external influences. We may watch to see how far present conditions agree with the verdict of 130 years ago.

The Productive Occupation of the Land.—As elsewhere, the activities of the people of Kent are closely related to the rocks that outcrop at the surface, to their water-bearing properties and to their soils. Varying bands of scenic and agricultural character, of density and kinds of settlement follow one another in succession from north to south.

From the Thames upwards to the crest of the North Downs, the surface is happily varied in its soil-cover and so in the life of its prosperous farms. The rich pastures of reclaimed salt-marsh and riverside alluvium are succeeded by the " orchards of aples and gardeins of cheries, and those of the most delicious and exquisite kindes " on the mixed soils of the London Tertiaries up to the 300-foot contour. Above that, on the clay-with-flints that still mantles the gentler slopes, there follows a woodland of beech, oak and scrub or cultivated fields, where cereals and roots figure conspicuously in the rotations. It was this threefold band that one old writer praised as " the daintiest piece of all our shyre." The number of villages and farms that stipple the map, and the large areas covered with the symbols for trees, prove that chalk lands are far from being the bare uplands that popular opinion thinks them. Only above 600 feet, in a narrow band along the summit and along the falling escarpment, lies the springy turf of open, grassy spaces.

The rich, closely peopled Vale of Holmesdale has a

narrow floor of Gault Clay, too heavy for cultivation, but of economic value as pasture-land and for brick-fields and rough earthenware. But this central ribbon is bordered on the two sides by lighter soils owing to mixture with the Upper and the Lower Greensands. The vale is a highly productive farm, like the belt that fronts the Thames. In its ordinary rotation, farming is diversified by hop-fields and orchards; for the latter the Vale has the inestimable boon of protection from devastating northerly winds at the time the fruit is setting. It is not inappropriate that East Malling in this vale was chosen as the site of a laboratory, where, under the conditions of a voyage in the model of a ship, experiments are made to improve the packing and transport of empire-grown fruit.

The Ragstone Ridge is made up of several layers, of which some are infertile. East and west of Sevenoaks infertility is suggested by the large areas of deciduous and coniferous woodland, common and heath. But south of Maidstone the number of hamlets and the close network of roads suggest that the lower, fertile beds reach the surface here. The one-inch map supplies the confirmation of many orchards, as it does for the two above-mentioned vales.

The broad levels of the Vale of the Low Weald are due to heavy clays, sodden and featureless. The wide bands of the same colour on the map and the uniformity of the spot-heights over wide areas, the ramifications of the Medway below Tonbridge and the dead-straight line of the Southern Railway, now followed by the official route of the Continental Airway, speak eloquently of its clay foundations. Although to-day it is drained and laid down in small hedge-lined pastures and orchards, the difficulties of clearing its marshes, willows and oak forest must have retarded colonisation. The absence of any main road from west to east and the general absence of villages, except round some railway stations, make one feel that development here came late.

The Low Weald is succeeded southwards by the rising country of the High Weald, where the tree-symbols on the map, the name Forest Ridge and the many place-names ending in -hurst justify the title of the Weald (*i.e.* Forest).

Modifications in farming practice are brought by the huge and concentrated market of Greater London. The demand has led here, as elsewhere, to the extension of dairying. It has led also to the development of market-gardens and to the growing of small fruit. In the reverse direction, London sends out seasonally the fruit and hop picker, as it sends out daily its train-loads of workers to sleep in Sevenoaks and other dormitory towns.

Destructive Economy.—Industries are variously related to local raw material from hill or farm, to the demands of agriculture and to the ease of transport by water. The conical roofs of oast-houses[1] are a familiar sight in every village of the hop districts, as breweries are of the towns. Lime works disfigure the chalk. The " Invicta " crest on agricultural machinery marks a Maidstone product. But the greater industries are maritime in character, concentrated along the river where the ease of transport feeds the paper mills of the Crays (on the stream of that name) with wood-pulp or favours the export of cement.

Spring-line Settlements.—The Maidstone District offers excellent examples of what are called " spring-line " settlements. Both the chalk of the North Downs and the sands of the Ragstone Ridge are porous ; the rain-water percolates down till it reaches the clay beds that underlie both (see Section XVI). At the junction of porous and impervious rocks the water is thrown out, and a line of springs marks the lower slopes of both scarps which the map shows to be along the 300-foot contour line. Here, then, are set lines of villages serving the vales. Reference

[1] *Oast-house,* a kiln for drying hops ; the word oast is connected with a root meaning heat.

to the map north and south of Maidstone will reveal a series near the base of the chalk from Boxley to Lenham and a second series along the base of the Ragstone Ridge from Linton to Sutton Valence and beyond. The same two series can be found on the map to the west of Maidstone by following the scarps. A geological map would disclose the fact that the villages generally find dry, sloping sites on the Upper Greensand rather than on the clay lower down.

From these concentrated nuclei men spread and dispersed over the less attractive clay flats in isolated farms, such as are dotted more particularly over the wider Low Weald. While, then, the spring-line village seems related closely to the fact of water supply, the isolated farm, with water plentiful on the wet flats, is free to attend to its own special activities; for the proper care of stock demands constant vigilance and frequent comings and goings, in contrast to the less exacting care of an orchard or of a field of growing crops.

Roads.—There is no space to enter fully into the courses and purposes of the lines of communication. A few significant points, however, cannot be passed over.

In the first place, the roads and railways serve two purposes. The networks of second and third-class roads and of local railway lines tie localities together and act as feeders of the larger district roads that tie communities to their regional markets. Rochester, Tonbridge and, above all, Maidstone, by the spider's web of roads which centre in each, unify their neighbourhoods.

Secondly, main thoroughfares and express lines are the tools particularly of external connections which treat the intervening country merely as a corridor. The chief demands come obviously from London at the one end and at the other from the Continent and Kentish coast resorts like Margate and Folkestone. The chalk ridge divides the main routes into two. Along the Thames Estuary, road

and railway march side by side and are coincident with the Roman Watling Street, crossing the Medway at Rochester. In the second case, road and railway part company. The main road crosses the chalk obliquely to Wrotham and then turns east along the Vale of Holmesdale; the railway neither climbs by the oblique route of the main road nor uses the easy gradients of the Darent Gap, but bores more directly by two long tunnels on its way to Tonbridge, before turning east to the channel ports. Rochester and Tonbridge, therefore, are railway foci; Maidstone is passed by. But Maidstone (Medway's town) remains a great central road focus, gathering, like Lincoln, seven or eight main district roads and a net of local lines. The town is thus marked out for and maintained as the regional capital. The quadruple city of Rochester-Chatham-Gillingham-Stroud is related more closely to main through routes by land and water. The fortifications, military "lines," batteries and dockyard, marked on the map, are only the successors of Roman garrison and Norman castle. It may be added that the revolution in means of travel and transport, brought by the motor car, motor bus and motor lorry, puts an enormous strain on the narrow High Streets of old-world market towns like Chatham and Maidstone.

Thirdly, the general road and rail pattern illustrates the guidance of routes by physical relief along the three vales, and in the case of the railways the advantage of the transverse river gaps for local lines. At the same time the freedom of human choice directs main roads and railways over or under the ridges, as dry foundations or the importance of speed respectively urge (Fig. 32).

Kent as a Thoroughfare.—The corridor character of this south-eastern peninsula gives to Kent a special prominence in the life of England. The country must have seen both the good and the ill effects of human movement according as it was friendly or hostile. There is something, at any

rate, on the map that speaks of its long, historic development.

First, the roads recall successive periods. The Ridgeway of the even, grassy crest of the North Downs led prehistoric men from the continent on their way to the once "densely" peopled region of the chalk uplands of Wiltshire. The map gives one visible sign of their settlement and burial by the way. Kit's Coty House (four miles north-west of Maidstone) is a prehistoric dolmen. The Roman imprint

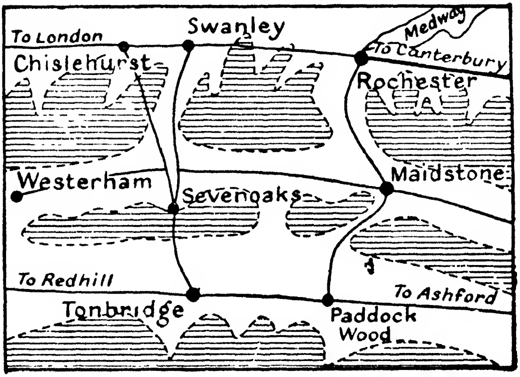

FIG. 32.—THE MAIDSTONE DISTRICT—RAILWAY PATTERN

remains in the military Watling Street, in the Roman camp at Ightham (three miles east of Sevenoaks) and in the name of Rochester.

But the Romans were conquerors, not colonisers. Real settlement came with Jutes and Saxons and is indicated here in the widespread -tons, -hams, -dens and -hursts of village names. Norman conquest and manorial organisation seem to appear in Sutton Valence and Boughton Malherbe at the spring-line of the Ragstone Ridge. And the story is carried forward by Leybourne Castle (five miles west-north-west of Maidstone), Boxley Abbey (two miles north of Maidstone), Rochester Cathedral and the

Road of the Canterbury Pilgrims along the slope of the chalk scarp.

In the sixteenth century continental refugees—Walloon, Fleming and French—found refuge here, near where they entered. They are said to have brought hops and fruit, and to have stirred an agricultural revival. They are said, too, to have introduced the local iron industry, based on the ore and charcoal of the Forest Ridge. Although ended by the rapid deforestation which brought laws against further devastation, place-names still exist as memorials of this village craft—Furnace Pond (three miles north-west of Goudhurst), Hammer Mill and Hammer Stream (five or six miles east of Goudhurst).

The continuity of evolution reaches modern times in the splendid mansions, old-world cottages and macadamised roads of the pre-steam period, in the shipyards, engineering workshops and railways of the present industrial age.

Other Large Scale Illustrations and Atlas Examples.—See the end of the next Section.

Reference.—*North-east Kent Regional Planning Scheme Report* (Chatham: Clements Bros., 1930).

SECTION XXIX

WATER-SEEKING SETTLEMENT—MANOR, PARISH AND FARM

WILTSHIRE FARMERS

And see you marks that show and fade
  Like shadows on the Downs ?
O they are the lines the Flint Men made
  To guard their wondrous towns.

KIPLING : *Puck's Song.*

The Map and the District Selected.—As for Section XVIII, Marlborough and Devizes (Special Hachured Sheet).

General Description.—In Section XVIII the district of Northern Wiltshire, as limited by the co-ordinates A–J, 1–9, was described as an aggregate of three structural forms : the scarped ridges and vales of the north-west, the Kennet chalk syncline of the centre and the anticlinal valley of the Vale of Pewsey in the south. We traced the line of the main chalk scarp diagonally across the map from Chiseldon to the Cheverells and noted that it was fundamental as the great dividing line of North Wilts. Just as the district was a compendium of surface forms, so it gathers together in a small area several types of adjusted human activities and groupings, some of which have already been illustrated in the study of the Maidstone and other districts.

First, in the north-west, the Corallian Ridge is patched with cultivated fields. It has been the objective of hill-seeking settlement ; Bremhill (C, 2) and Lyneham (A, 3)

are on its back, and Clack Mount (A, 2) and the hill camp suggest partly defensive determinants. Isolated farms pepper, as it were, the wet, clay flats and their meadows which are the raw material of the dairyman.

Secondly, along the spring-line of the main scarp, where Upper Greensand rests on Gault Clay, there nestles a line of villages from Chiseldon to the Cheverells; this series is part of a long band of "under-cliff" hamlets, set a mile or two apart and extending from Yorkshire to Dorset. Isolated dairy-farms again are dispersed over the neighbouring wet, clay vale (Plate VIIB).

Thirdly, on the slopes of the chalk within the Kennet syncline visible water is absent, except for the river itself; and the subterranean water-table lies deep. Human grouping responds by collecting a line of villages along the river from Broad Hinton near its source to Marlborough and beyond. No better example of concentrated settlement could be found. Away from the river almost the only dwellings are either the few cottages on the dry valley floors, where natural erosion has lowered the surface towards the subterranean water-table, or the big racing establishment which can afford to sink and work the deep well.

Fourthly, in the Vale of Pewsey, the two inward-facing chalk scarps shelter two series of spring-line village nuclei, with small dairy-farms spilt over, as it were, on to the Upper Greensand floor.

A Treasure-House of Pre-History.—Reference was made in the last Section to the fact that the open Wiltshire Downland, where there was no forest to clear, was the seat of a "dense" population in the pre-historic period; the Chalk is indeed a treasure-house of pre-history. Camps and cattle-pens on the summits protected the lives and activities of those who lived there: Barbury (B, 7) and Bincknoll (A, 5) Camps on the main scarp; Martinsell (F, 8), Knap Hill (F, 6), and Rybury (F, 5) along the

northern wall of the Vale of Pewsey. Burial places in long (E, 5 and 6) and round (D, 5 and 6) barrows are scattered broadcast; the Devil's Den (D, 7) is a dolmen, like Kit's Coty House, near Maidstone. Earth-works dot the map. Flint implements and weapons are widely found. The culmination of the rich store lies in the circles of fosse and unshaped stones of the "temple" at Avebury and of the later, shaped trilithons[1] at Stonehenge. The view of Avebury on Plate XI, taken from vertically above, shows the circular ditch with the narrow standing-ledge and earth rampart on the *outside*, a fact which excludes it from defensive works. Within the ditch, the circumference of which extends for three-quarters of a mile, what is left of the circles of huge sarsen stones can be made out. One circle lined the inside edge; of this a few stones are still standing. Within this large circle two smaller ones filled the interior, and of these also a few stones are visible. But, for archaeological matter, reference must be made to the many special works on the subject. The view shows how the present village has been built partly inside and partly outside the circle, and the contact has been one of "destructive economy," for most of the stones have been broken up to build cottages, barns and walls.

The Downward Migration of Settlement.—The hill-top camp or "castle" has been mentioned. Within a distance of some dozen miles four stand up on the summit of the chalk ridge in North Wiltshire and Berkshire. Barbury and Liddington Camps are marked (B, 7: A, 9); the contours make clear the defensive strength of such sites. Just off the map to the east, in Berkshire, two others—Uffington and Letcombe (or Segsbury) Camps—extend the line to the gap of the Thames. They are connected, as the map tells us, by a grassy Ridgeway.

The lack of water on these summits must have created

[1] *Trilithon*, a structure of three large stones, two upright and one resting on them as a lintel.

no small problem in times when it was unsafe to descend to the scarp springs and the forest below, and in some cases the difficulty was met by the famous "dew-ponds" that still dot the high Downs, are fed by rain and mist and still supply shepherds and their flocks. And the winds, which can sometimes be piercingly cold, cannot have been readily acceptable even to a hardy hunter. When, then, peace and the arts of civilisation developed, men began to settle lower down, in the spring-line villages already mentioned, united by a foot-hill road. From here they spread out on to the wooded lowlands, where grew market-towns at river-crossings or other nodal points. Still later, with the coming of the railway, industrial or commercial towns grew out in the plain, joined by the railway, and such examples here are engine-making Swindon and the great junction of Didcot.

Another interesting example of similar downward movement of settlement occurs at West Lavington (J, 2) on the south-western edge of the Vale of Pewsey. Three parallel lines of settlements and connecting roads can be traced on the map: the hill-top camp (the huge Bratton "Castle" is just off the map) and Ridgeway along the chalk summit: the foot-hill villages and roadway on the Upper Greensand of the lower slopes of the scarp; the towns and the railway further down on the Gault Clay. The accompanying diagram (Fig. 33) will help towards sorting out the facts from the one-inch sheet. The down-hill extension of the village itself is suggested by its form on the map, to which the plan adds further relevant details. The old village lies just below the scarp springs. Its old, thatched, white-washed cottages are built, as the map shows, in clustered form round a mesh of lanes. The later extension down towards the cross-roads is marked by a long and attached "street" village, related to the traffic on the Salisbury road; it can be seen to be reaching out still further down towards the Great Western Railway, a section of the route of the

Cornish Riviera expresses. A visit, or even the six-inch sheet, would show how an oblique line from south-west to north-east divides the old clustered settlement of thatched white-washed cottages, church, manor house, grammar school and mill from the later houses of brick

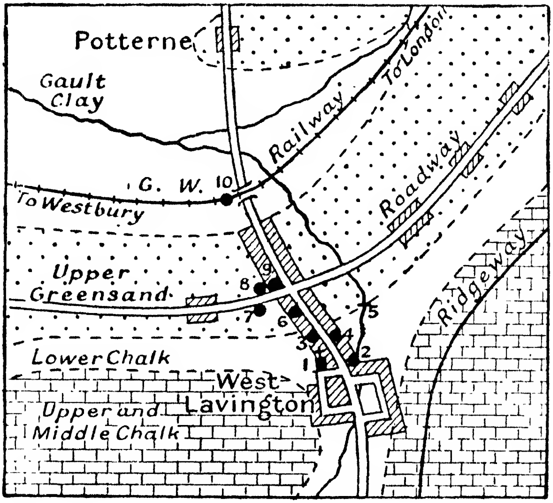

FIG. 33.—WEST LAVINGTON—THE DOWNWARD EXTENSION OF SETTLEMENT

1 Church.
2 Old Grammar School.
3 Manor House.
4 Home Farm.
5 Mill.
6 Elementary School.
7 Secondary School.
8 Chapel.
9 Telegraph Office.
10 Station.

and slate which border the main road, one house deep, and among which are to be found the later elementary and secondary schools, chapel and telegraph office.

The Arrangement of Manors and Parishes on the Chalk.— The medieval village was of necessity all but self-sufficing. Water, food, clothing, building materials and fuel had to be obtained locally or not at all. The shapes and

arrangement of the ancient manors and their modern representatives, the parishes, on the chalk are related in simple fashion to the physical conditions that supplied these varied needs.

Scarp settlements were placed near the springs. From these nuclei the manors ran in one direction up and over

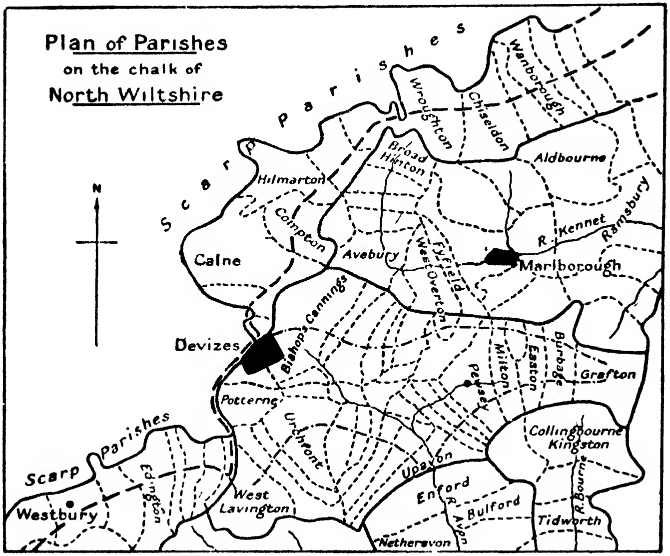

FIG. 34.—NORTH WILTSHIRE—PARISHES ON THE CHALK

The thick broken line is the main chalk escarpment. The dash-dot lines mark the two escarpments of the Vale of Pewsey. The thick continuous lines divide the parishes into groups. The thin broken lines are parish boundaries.

the scarp on to the chalk grass land, in the other downwards over the wet, wooded, clay plain. So they had the form of long, narrow rectangles, set transversely to the scarp across the bands of differing soils. Each manor and parish thus obtained a share of sheep-walk, plough-land, cattle-pasture and timber. The western band of parishes on the accompanying plan (Fig. 34) shows their clear-cut form and

grouping along the main scarp in Wiltshire; a few names are inserted to enable comparison with the one-inch sheet. It will clarify the map a great deal if it be coloured in three different tints, according to the three groups enclosed by thick lines: (1) the scarp parishes, (2) those of the Kennet Downfold, (3) those of the Vale of Pewsey. It should be noted that parish boundaries are marked on this sheet of the Ordnance Survey.

The Vale of Pewsey also shows the same nice adjustment of administrative divisions to natural groundwork. At the narrow head of the Vale the parishes, like Pewsey, cross the whole width from one side to the other. As the Vale widens westwards, the northern and southern scarps each have their own lines of parishes, of which Urchfont and Bishop's Cannings are representatives, and northern and southern lines are in contact along the centre. Towards the broader west the two series are parted by a narrow band of small central parishes.

On the slopes of the Kennet Downfold, the Kennet itself and shallow wells in the gravel terraces along its flanks are the sources of water. The people are concentrated in small groups of fifty to two hundred souls at short intervals along the river; there is hardly a dwelling elsewhere. Parishes are arranged in long, narrow rectangles across the Kennet, and extend up on to the Down on either side; each parish thus has its share of water-meadow near the river, ploughland on the lower slopes, and downland grasses above, and farms frequently follow the same transverse trend.

It should be noted in the figure how the parishes of the southern scarp of Pewsey Vale pass neatly to the trans-riverine arrangement across the Salisbury Avon by means of the triangular parish of Upavon. Salisbury lies in a hollow, where five chalk streams meet; each stream has its own ribbon of parishes, which either join at the river in pairs or stretch across the whole valley from water-parting to water-parting. The whole forms a simple fan-

shaped pattern, convergent on the confluence of the five rivers.

Generally speaking, a parish coincides with a manor. Milton Lilbourne (Middle-ton de l'Ile Bonne) and Fyfield (G, 8), however, seem to have been combined into one parish; conversely, the Manor of Preshute is divided between Preshute and the urban parish of Marlborough.

Parishes on the north-west of the sheet, such as Hilmarton (B, 3), amid surviving patches of the ancient Forest of Braden take a different form. Hilmarton shows a star-pattern with the church in the middle whence it sends out fingers, as though representing extensions along forest glades or paths from the settlement in a central clearing. The parishes of the south-east of the sheet, *e.g.* Vernham's Dean (H, 13), have a similar pattern amid the remnants of the ancient Chute Forest; this parish shows a central church (alone), surviving patches of wood, projecting fingers and star-pattern road system to match.

The Farms, Dwellings and Roads of a Parish.—Like the parishes, the farms are adjusted to the geological bands, their soils and their water-bearing character.

The farms along the Kennet, typically long and narrow like the parishes, run from the river up on to the Down, so that they too include strips of water-meadow, arable land on the lower slopes and downland grass above.

The farms along the scarps, also often long and narrow like the parishes, cross the bands of different soils, clay flats with pasture fields, Upper Greensand, which is here cultivated, and the grassy scarp.

The accompanying Fig. 35 sets out details of the parish of Milton Lilbourne in the Vale of Pewsey. The left-hand plan shows how the rectangular form is stretched across the geological bands, each with its own kind of product—open-air milking herds on the Down, fodder crops on the marly Lower Chalk, dairy farms on the Upper Greensand. Formerly, the Down was sheep-walk, but

sheep have gone from here. The Lower Chalk was once famous for its wheat, but now only a little is grown to obtain straw for thatching. The cheapness of oversea wheat and the demand of London for milk are the chief reasons for the change. The third feature is the typical cross-shaped road plan. A lengthwise second-class local

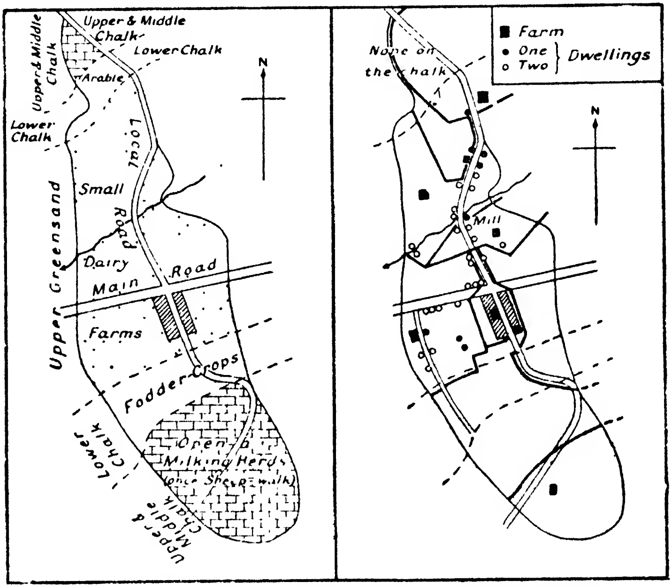

FIG. 35.—MILTON LILBOURNE PARISH, VALE OF PEWSEY

(*a*) GEOLOGY, PRODUCTION AND ROAD PATTERN. (*b*) FARMS AND DWELLINGS

(or parochial) road links the soil strips of the farm and the whole to the village centre; a cross-wise main (or inter-parochial) road links parish with parish and farm with market.

The right-hand figure gives two sets of detail. First, dwellings are distributed in relation to water and work—nothing on the chalk, except one hill farm: the village

on the Upper Greensand where it meets the Lower Chalk: dwellings scattered over the water-holding sands. Secondly, the farms that run over the chalk are large, often up to 1000 acres, with big, unfenced fields; those over the sands are, as a rule, much smaller, 50 to 150 acres, divided into small hedge-lined fields with the homestead central. Fig. 36 shows such a farm. The right-hand plan in the same figure is of a farm in Savernake Forest.

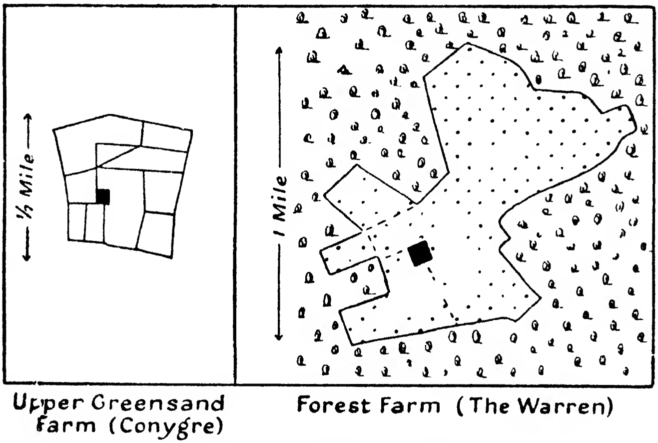

FIG. 36.—PLANS OF FARMS

From a central homestead the farm extends outwards in lobes, as though extended along glades or forest paths; it recalls the pattern of some of the forest parishes, like Hilmarton or Vernham's Dean, mentioned above.

Other Large Scale Illustrations.—Besides the maps of the Maidstone and North Wilts. Districts, the Lincoln Sheet gives beautiful examples of spring-line settlement along the Cliff to the north and south of the city. It is worth while getting a sheet of the Coloured Edition, of which some are still obtainable, and marking out the parish boundaries. Failing this, the county parish-plan will

serve. The parishes, about a mile in width and three or four miles in length, run across the scarp; Coleby and Boothby Graffoe, for instance, with populations concentrated in their villages, include the wet, clayey, hedge-lined pastures of "Low Fields" and the dry, limestone-walled ploughlands of "the Heath." From the eastern ends of these the parishes of Dunston and Metheringham extend across heath, woodland and fen, of similar width but double the length. The cross-pattern road plan of the chalk parishes is repeated.

North of Lincoln the same shape of parish crosses the scarp and all end on the Roman road. Eastwards, however, the extent of woodland and absence of fen seem to account for the round or star-shaped forest form, the central clustered village and a road-system in harmony; Nettleham is a round parish; Scothern and others are characterised by projecting lobes.

References.—*The Village Community*, by Harold Peake (Benn) has much that bears on the subject-matter of this and the preceding section. Charlotte A. Simpson's ***Rediscovering England*** (Benn) has two detailed chapters on ***The Geographical Control of the Sites of Villages and Shapes of Parishes.*** H. C. Brentnall and C. C. Carter's ***The Marlborough Country*** (Oxford Press) deals with many aspects of North Wilts. and was designed for school use.

A SUMMARY OF DENSITY PATTERNS

Having thus studied on a variety of large-scale maps some human distributions, partly in relation of surface, soils and water and partly in relation to human activities in mining, farming and movement, one might profit by

trying to visualise and carry in summary fashion a few simple types of distribution and their associated roads.

The solid Vesuvian Cone was girdled by a ring of settlement, a simple form which developed into the ring and spokes of the radially dissected Cumbrian Dome. The shape was altered in broad Tweed-dale and its upland tributaries to that of a hand and finger-like extensions. Parallel bands were determined by relief in the mountain valleys of Monmouthshire, in the folded troughs of Southern Ireland and in the Ingleborough Dales. Human interests in mines, cultivated fodder crops and rough mountain pasture graded density from closely packed urban bands through rural villages and markets to a discontinuous line of hamlets and isolated farms.

In a similar way, the parallelism of scarped ridges and vales is met by appropriate belts of alternating density and scarcity, with village nuclei along the spring-line beneath the scarps and farms scattered over the flats.

On lowlands, where the guidance of relief is less in evidence, the chief part is played by the soils and their water-bearing character. On the gently undulating gravels of the plain of the Trent, villages and farms, though in close neighbourhood, are widely and evenly spread, seemingly at random, except that they shun the waterlogged flood-plain, while, contrariwise, on the dry chalk the people gather in clusters along the river, leaving the Downs almost bare.

PART V

COAST FORMS

SECTION XXX

THE CLASSIFICATION OF COAST FORMS

There rolls the deep where grew the tree.
O earth, what changes hast thou seen !
There where the long street roars hath been
The stillness of the central sea.

TENNYSON : *In Memoriam.*

General Description.—Coast forms are of infinite variety, as a result of the many processes that contribute to their formation. But the distinction should be carefully borne in mind between the major forms, which are originated by earth movements, and the minor forms, which, due to the action of the sea and rivers, modify major outlines during their Life Cycle.

Major Forms are the result of earth-movements. They are of two kinds. *Emergence* of the smooth sea-floor gives rise to simple, smooth outlines. If the emergence has been gentle, shallow seas generally lean against a low coastal plain ; if the emergence has been strong, then the coast, though still simple, may separate deep water from high land. The south-eastern coast of United States is an example of the former, the west coast of the latter.

Submergence, on the other hand, gives birth to embayed coasts, as in Canada and Europe. The character of these depends on the surface of the country which suffered submergence. Drowned mountain country becomes a ragged complex of narrow straits and inlets, peninsulas and islands—generally deep water and high land, magnificent harbours but often shut out by mountain barriers from their

hinterland. Such is the irregular and intricate west coast of Argyllshire or Kerry, each of which is illustrated here (Sections XXXI and XXXII). The coast of Dalmatia is added (Section XXXIII).

Over a drowned lowland the sea-water spreads in wider, shallow sheets or up shallow valleys; and islands and peninsulas correspond. Hudson Bay, Baffin Land and the north coast of Canada generally, or the coasts of Sweden and Finland, exemplify outlines of drowned lowlands of denudation. The estuaries of the Stour and Hamford Water (Section XXXIV) are the visible signs of a coastal plain, whose shallow depressions in soft, unconsolidated rocks have been covered, and they are matched in America by the broad shallows and estuaries of Chesapeake Bay; they are known as the Maryland Type.

Minor Forms are the results of the action of sea, rivers and other agents, and are especially conspicuous along embayed coasts. Marine erosion trims back protuberances; deposition by rivers, alongshore currents, waves and winds fill up re-entrants. By the action of such destructive and constructive forces the ragged outline grows to its appropriate curve of equilibrium. Illustrated here are spits and lagoons (Section XXXIV, Ipswich), promontories and beaches (Section XXXV, Barnstaple), and cliffs, coves and shore-platforms (Section XXXVI, Isle of Purbeck).

Reference.—D. W. Johnson: *Shore Processes and Shore line Development* (Chapman and Hall).

SECTION XXXI

A FIORD—SUCCESSIVE BASINS

LOCH ETIVE

Let me feel the breezes blowing
  Fresh along the mountain side,
Let me see the purple heather,
  Let me hear the thundering tide.

AYTOUN.

The Map.—On the whole the best map is Bartholomew's Half-inch Reduced Survey, Scotland : Sheet 11 ; although its contour interval is wide, it includes Loch Awe and its glens as well as other related features. The One-inch "Tourist" Edition (Oban and District) and the One-inch Popular Edition (Scotland, Sheet 54) contain contours at 50-foot intervals, but include only part of the area and have fewer submarine contours.

The District Selected lies on the western coast of Argyllshire ; it includes Mull and the flanking Loch Linnhe and the Firth of Lorne.

General Description.—A diagram is given to show the general geological background. A granite mass surrounds Upper Loch Etive ; the granite region is made up of high mountain and deep glen, wild and inaccessible, and culminates in Ben Cruachan, overlooking the Pass of Brander and Loch Awe. South of the Pass of Brander denuded lava sheets give rise to much lower flat-topped, terraced table-mountains like Beinn Glass. Over the rest

of the map the ordinary metamorphic rocks of the Highlands raise rounded summits.

The conspicuous water-features of this highly embayed coast bear little relationship to the geological foundation. There are two direction-lines cutting through all three areas. The one is consequent and lies south-west to north-east; it is marked by Lochs Linnhe, Creran, Upper Etive, Awe and Fyne. The other, subsequent, lies at right angles,

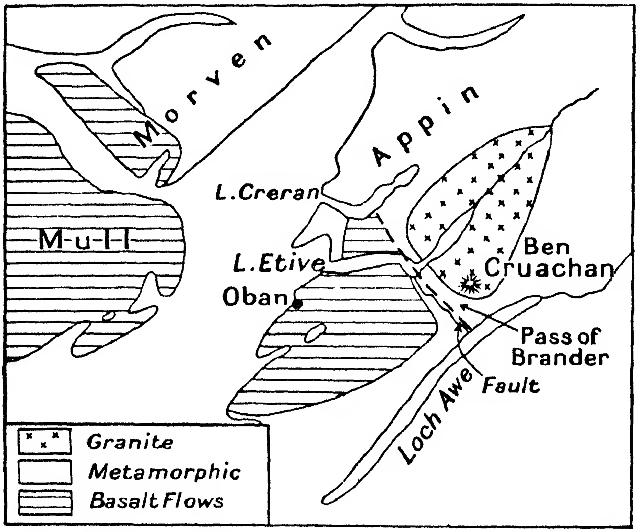

FIG. 37.—LOCH ETIVE DISTRICT—GEOLOGICAL PLAN

from north-west to south-east, and is marked by the Sound of Mull, Lower Loch Etive and the Pass of Brander. The normal cycle of erosion has been complicated by the accidents of frequent fracture-lines as well as by the interruption of the Ice Age.

Loch Etive as a Fiord.—On examination the following features in Loch Etive can be read from the map. It is long (18 miles) and narrow (half a mile to a mile), bounded

by high walls (2000 to 3000 feet). Note that the contour interval here is 250 feet. The glen, in which the loch lies, is continued with the same characteristics for a further ten miles into the Highlands as Glen Etive. The map and the view (Plate XIIB) show that these walls are steep. The view is taken from the neighbourhood of Glennoe and looks north. The general rounded outlines of ice-work are visible; the smoothed rock protrudes through the shallow soil. The shore-line here is more irregular than further up. In the foreground and across the water are the ledges of a raised beach which runs round Loch Etive. It drops steeply into the water and rises steeply behind. In the distance can be made out, with the help of the map, Beinn Trilleachan near the loch and Beinn Mheadhonach, and, behind, Beinn Sgulaird and other summits.

The shape of Loch Etive is made up of three reaches, of which the short middle section, two miles in length, lies on the fault line of the Pass of Brander and Gleann Salach The depth of the loch does not increase uniformly seawards; at least two obviously shallow lips are indicated, one at Bonawe and the other at the mouth. At Bonawe and at other places, opposite shores close in to a quarter of a mile. A closer examination of the under-water contours discloses seven or eight such basins, the deepest of which, above the Bonawe constriction, goes down more than 500 feet. The deepest sounding, then, is not at the mouth but half-way up, and here the floor of the loch is 500 feet below the level of the sea.

Across the mouth of the loch lies a lip or reef, covered at high tide but partially exposed at ebb. The flow and ebb rush in and out with great rapidity. During part of the time the tidal current breaks on the lip into "a roar of angry foam," which forms the Connel Falls or Falls of Lora, to be heard a mile away. The depth inside the lip is 420 feet, while two miles outside it is only 168 feet; at the Falls the depth is 6 feet at low water. The shallowness and the constriction have facilitated a railway bridge.

The Causes of Fiords.—Such are the facts. Their cause is more difficult; for there is a conflict of opinion among geologists. Perhaps it may be said that the valleys were originally the work of rivers. The straightness of the valley walls, however, is not characteristic of a graded stream, nor can a river erode below the base-level of the sea. Further, the U-shaped cross-section is unlike the V-shaped valley of a mountain stream. Hence the deepening and modifying effects of a valley glacier must be called in aid. Later the lower glen was drowned through submergence. The sharp right-angled turns and the entry of tributary embayments at right angles suggest that fracture-lines play a part also.

Stages of Submergence.—Various stages of submergence from glen loch to sea loch are clearly illustrated on this sheet. Very little emergence, 20 feet, would raise the Connel lip above the reach of high tide. Very little submergence would convert Loch Awe southwards into a sea loch. At the time when the shore-platform, represented by the 50-foot beach of this coast, was forming under wave attack, Loch Nell and Loch Feochan were one. There are represented here, therefore, three chapters in loch history. Submergence has been insufficient to drown the southern entry to Loch Awe, south of Ford. It has been sufficient by 20 feet to convert Loch Etive into an arm of the sea. It has been more than sufficient in the cases of Lochs Creran and Leven.

Although submergence has been followed by emergence to the extent of 100 feet, this has not been enough to obliterate the effects of the submergence, except that it has shut off Loch Nell from direct access to the sea.

The whole region presents an array of peninsulas and islands, interlocked with sounds and sea lochs, as a consequence of which Atlantic winds, mists and rain penetrate far. The region has been described as at its grandest when Nature is in wild mood during winter storms, when westerly

gales hurl angry breakers on the headlands, the wind howls up every glen and foaming torrents fill every gully.

Atlas Examples.—The classical example of a fiord-coast is, of course, that of Norway with its " skerry guard." The Trondhjem, Sogne and Hardanger Fiords are many times larger than Loch Etive. The coasts of British Columbia and of southern Chile also offer magnificent fiord and island scenery. In New Zealand the Sounds of the south-west coast of South Island are fiords, of which Milford Sound is the best known.

(For the associated human study, see Section XXXVII.)

SECTION XXXII

RIAS—DROWNED VALLEYS

KERRY

In all her length far-winding lay
With promontory, creek and bay,
And islands that, empurpled bright,
Floated amid the livelier light,
And mountains that, like giants, stand
To sentinel enchanted land.

SCOTT : *Lady of the Lake.*

The Map.—Bartholomew's Quarter-inch Reduced Survey, Ireland; Killarney and Cork as for Section XVI.

The District Selected.—The coast of Kerry.

General Description.—When folding in a region is followed by submergence, the resulting forms of coast-line are so definite, and moreover so common, that we speak of types. There are two main types. Where the drowning has taken place transversely across the end, long interlocking bays, peninsulas and their island extensions result; such are seen in Greece and Kerry; perhaps we may call it the Kerry type. Where the flanking ridge has been invaded, we call it the Dalmatian type and find it typically along the western shores of the Balkan Peninsula. The nearest approach to this latter type in the British Isles is provided by Cork Harbour.

The Kerry Coast.—The three major folds named in the diagram on page 99 are extended westwards with their

complementary downfolds. The Cork Upfold reaches the Atlantic in the Caha Peninsula. The Central Upfold continues via Bantry to make the Red Sandstone cliffs of Sheep's Head. The Southern Upfold projects as the southern flank of Dunmanus Bay and ends at Mizen Head.

To the south of these, other subdued folds run parallel. One passes to the south of Skibbereen through Sherkin Island to Cape Clear. Another fold bisects the three peninsulas that end in Galley Head, Seven Heads and the Old Head of Kinsale.

The Rias.—With the submergence of this western end beneath the Atlantic, the troughs of the downfolds became flooded. They should deepen and widen uniformly down-bay. This is the case, but the map does not give submarine depths to prove it. But all, except Roaringwater Bay, where the relief is more subdued—Dingle Bay, Kenmare River, Bantry Bay and Dunmanus Bay—are straight-edged. The tributary valleys are ill-developed down the upfolds ; only the lower ends have been trenched deep enough to feel the effects of the drowning. In consequence tributary bays are comparatively few and insignificant. Such, however, are Parknasilla Bay and Kilmakilloge, opening into Kenmare Ria ; Glengariff and Adrigole Harbours, opening into Bantry Bay. It may be noted that the Kenmare Ria is still called River, just as the Bretons and Galicians use the same term (rivière, ria).

The *rias*, like estuaries and unlike fiords, widen uniformly towards the sea. Dunmanus Bay, for instance, in its fifteen miles of length widens to four miles, Bantry Bay to six, and Kenmare River to eight.

They each stab inland along the troughs, into the floors of which small streams like the Roughty, Owvane and Fourmile Water have eroded inner valleys. These streams are naturally silting up the bay-heads, clearly shown on the map at the head of Kenmare River and Dunmanus Bay ; the process is retarded by the scour of the tides.

which enter direct from the Atlantic Ocean. In Dingle Bay, however, the tide has beaten up a triple barrier of sand-spit and blocked the inner five or six miles, so that it is passively responsible for the acres of mud which are exposed at low tide in Castlemaine Harbour.

The Peninsulas are long—five to thirty miles—and narrow seawards. North and south of Kenmare River the Old Red Sandstone backbone rises as mountain land, thinly inhabited up to 1000 feet. Woods reach 1500 feet; above are heather and barren crags. On the north Macgillicuddy's Reeks rise over 3000 feet; on the south the Caha Mountains and Slieve Miskish reach 2000 feet. Apart from a marked gap through the latter, which goes down to 300 feet, there are few crossing places. The road from Glengariff to Kenmare mounts to 1000 feet and even then requires a tunnel; and the steep gradients are evident from the turns and twists that are required.

Atlantic breakers are trimming back exposed coasts into cliffs and shore-platforms. The drowning of transverse valleys or the work of marine erosion has cut off the ends of the peninsulas into the continuing lines of islands shown.

Cork Harbour.—The sheet following, of the Dalmatian Coast, provides the typical example of the submergence of the flank of a folded region. If the south coast of Ireland had been submerged sufficiently far, we might have had here examples as illustrative as Dalmatia. As it is, Cork Harbour, with its two narrow, steep-walled entries and two wide basins, alone is useful for comparison (Plate VII).

Atlas Examples.—The name *ria* comes from Galicia in North-western Spain and may be there found, if the atlas is detailed enough. In the narrow sense, it seems that the term should be applied only to the long, winding, submerged valleys in granitic regions such as Galicia (Ria

Vigo) and Brittany (Rivière de Landerneau, Rivière de Châteaulin, which lead to the Rade de Brest). Plymouth and Falmouth Harbours and Milford Haven would come into the same category, if Old Red Sandstone were substituted for igneous rocks. But the meaning is extended to include the bays of South-western Ireland, and repetitions of the drowned ends of downfolds and of the river valleys cut into their floors are especially conspicuous in the "prongs" and bays of the Peloponnesus.

SECTION XXXIII

DALMATIAN TYPE—LATERAL CHAINS

ZARA

> Thy pole-clipped vineyard,
> And thy sea-marge, sterile and rocky-hard.
>
> SHAKESPEARE: *The Tempest.*

The Map.—Austrian Staff Map—Scale 1/200,000: Sheet Zara.

The District Selected comprises the coast features of Dalmatia north and south of Zara, that is, the west of the Balkan Peninsula and the east of the Adriatic.

General Description.—The region consists of folded ridges and troughs, marked as usual by parallel bands and here aligned from north-west to south-east. It is a part of the Dinaric Alps, which border the west of the Balkan Peninsula and the east of the Adriatic Sea. The town of Zara appears towards the west side of the northern half of the sheet, and the whole should be looked out in the atlas in order to "place" it among its wider surroundings. On this sheet two distinct kinds of country are shown, the unbroken mass of the mainland and its island-fringed foreground next the sea.

The Mainland.—On the north-east of the sheet is a triangle of high land. Examination of the spot-heights and the shading reveals a mountain mass, rising in parts to 5000 feet. It is named on the map, the Velebit Range.

Apparently it presents a steep, bare or grassy face towards the sea, but is clothed in part with woodland on its Balkan slopes. It seems unbroken by passes and must form here a difficult obstacle to contact between the sea-coast and the interior. Indeed, only one road passes inland and that winds abnormally; and no lengthwise road runs along the northern part of the coast.

On the inside, that is, north-east, the coast range overlooks a long trough, easily followed on the map by two or three lengthwise rivers, a road and the black dots of dwellings, beyond which, again, is a second but lower ridge. The rivers, marked in blue, stop short; they disappear underground. This fact immediately recalls Ingleborough and a limestone region with its swallow-holes, caves and water-issues; and the general absence of streams and forest over the highlands lends added strength to the resemblance. Not a single mountain stream enters the Canale della Morlacca.

The Coast.—The interior highlands throw out into the Adriatic a low platform, some 30 miles in width and rarely rising to 500 feet in height. The outer flanking folds of the Dinaric Highlands have been submerged. Adriatic water has invaded the troughs up to the line of the first high wall and produced an intricate fringe of interlocked peninsulas and embayments, islands and channels. But here there is none of the chaotic character that stamps the island-fringe of the coast of Norway. The peninsulas, islands and channels fall into an ordered system whose limestone rock, folded structure, subterranean drainage and alignment from north-west to south-east repeat at a lower altitude the traits of the mainland.

It is not easy to make out from the shading which are the ridges and which the troughs. Speaking generally, the green shading of woodland shows up the ridges, and this may be confirmed or rejected, as the case may be, by a careful study of the spot-heights. The troughs may

be traced out, too, by the lie of the lengthwise streams, lakes and forked ends of peninsulas and islands; the lengthwise roads and bands of settlement assist further.

The chief characteristics, then, are chains of long, narrow islands (*isole*), light grey ridges of limestone "like gnawed bones," parallel to the new coast-line; they are both large and small and represent undrowned portions of ancient ridges. In places they form at least a triple line of which the names can be read from the map, and they offer many safe anchorages. The inner bands apparently are not completely detached; for Isola Pago is set head on, as it were, to a broad peninsula, itself forked, like the islands, into three prongs at its north-western end. It would not require much further flooding to extend the Canale della Morlacca another ten miles south-eastwards by converting the two lakes into a continuation of itself.

Complementary to these lengthwise island-chains and peninsulas are long, narrow channels, which form a splendidly protected inner waterway, some compensation for the difficulties of movement by the land. The lengthwise channels (*canali*) are narrow, but straight and direct; such are the Canali di Zara and Mezzo and the Canale della Morlacca. The ends of islands, as already mentioned, are frequently forked, where minor troughs or denuded vales have been invaded; such cases are visible in Pago to the north and in Grossa to the west. No doubt chemical solution has played a large part in their formation; a water-filled "sink"[1] at the northern end of Isola Pago seems on the verge of being converted into such an arm of the sea.

But besides lengthwise troughs, deep-cut transverse gorges have been drowned. The long ridge-backs have been broken up into chains of islands by narrow, zigzag

[1] A *sink* is a hollow, eaten out of the surface limestone by chemical solution or produced by the subsidence of the surface layers when undermined by the same process. It collects soil residue and, when not covered with water, is cultivated.

channels, which contrast with the directness of the *canali*. The whole map supplies examples in the straits that lead from the coast to the open sea, but perhaps the most striking one is that which separates off Pago at its south-eastern end. All stages in the making of peninsulas, islands, lengthwise *canali* and crosswise straits can be detected here.

Other Large Scale Illustrations and Atlas Examples would naturally be searched for where folds flank the sea, that is, on the west coast of North and South America. At the northern end, from Puget Sound, the Straits of Georgia and Vancouver Island, is a protected sea-way to Baranof Island and the intricate channels and islands of the Alaskan "pan-handle." At the southern end the same type of coast is repeated in the southern third of Chile, from Puerto Montt to Tierra del Fuego. Perhaps, too, the observant will think back to the peninsulas, islands and channels off the south-west of Ireland and off Loch Etive.

The type of harbour with narrow entry and wide basin, to which attention was called in the case of Cork, has parallels in the case of the Golden Gate and San Francisco Harbour, opening to the Californian Valley. The best known of such sheltered basins is that of the double harbour of Cattaro, further south than Zara on the Adriatic coast.

(For the associated human study, see Section XXXVIII.)

SECTION XXXIV

ESTUARIES—TIDAL SCOUR

ESSEX AND SUFFOLK

With ceaseless motion comes and goes the tide ;
Flowing, it fills the channel vast and wide ;
Then back to sea, with strong majestic sweep
It rolls, in ebb yet terrible and deep ;
Here samphire-banks and salt-wort bound the flood,
There stakes and sea-weeds withering on the mud.

CRABBE : *Seaport and Inland Scenes.*

The Map.—Ordnance Survey, England—Scale, 1/63,360 ; Sheet 87 (Ipswich) and 98 (Clacton-on-Sea and Harwich).

The District Selected.—The coast features of parts of Essex and Suffolk from the Naze northwards.

General Description.—The region is one of faint relief, mostly under 100 feet, and the slopes, except down into the river valleys, are gentle. Three types of feature are distinguishable : the contoured area, composed of soft, unconsolidated glacial and river gravels and clays ; the white coast patches, especially round Hamford Water with its tree-pattern tidal creeks ; the estuaries of the Orwell and Stour, formed by submergence and maintained by tidal scour. The word estuary means tidal, and it is this tidal scour that is the outstanding phenomenon. Without tides estuaries would soon be silted up ; there are no estuaries in the Mediterranean.

The Stour Estuary is a type case. The tidal stream, that comes twice a day from the north, enters the estuary at

Harwich Harbour. In its advance up the river it has two opposing forces to overcome. It is working against the current of the river and of creeks, like Holbrook Creek, and also against gravitational forces up the valley and up the fringing mud-banks. The ebb, therefore, is stronger to do work and removes the silt which the incoming tide brings. Still more, the incoming tide ponds back the Stour water, and this extra supply escapes only as the tide goes down.

Thus the Stour, with the help of the tides, has scoured out a channel of considerable depth and width. The map marks clearly the channel, the mud-banks which are alternately covered and exposed, the creeks which drain the banks, and the walls and embankments which protect the country on either side.

Certain characteristics favour estuarine form. The stream must be stronger than the along-shore currents. Otherwise a spit will be built across the mouth, as is being attempted at Landguard Point. Such a spit is the first step in the diversion of the river and in the subsequent alluviation.

Hamford Water.—The low-lying land of the East Coast shelves gently beneath the sea. On such a coast many thousands of acres of sand and mud-flats are uncovered at low tide. The five-fathom submarine contour shows the shallowness between Harwich and Frinton. The whole 8000 acres drained by Hamford Water form a kind of debatable zone between solid land and sea. On the seaward edge it consists of sand, clay and mud at low tide; at high tide it is a sheet of water. On the landward edge it is an expanse of marsh, useful only for decoy-ponds, for wild fowl, and for rifle ranges. Horsey Island and other patches have been embanked and reclaimed.

The contrast between the concentrated scour of the long, straight Stour and the dispersed weakness of Hamford Water is clear. The depth at Crabknow Spit is only seven

feet. Even so, it forms a useful refuge for small craft which cannot make Harwich Harbour at the onset of sudden storms.

Orford Beach.—This long spit consists of a series of concentric shingle ridges or "fulls," separated by corresponding furrows. Most spits are characterised by such parallel waves of pebbles. Each seems to represent the work of some great storm, piled up with a steep rise facing the sea. The material is brought by along-shore currents, the direction of which is shown by the point. This beach, therefore, has been built from a root near Aldeburgh and has grown ten miles southwards. Two detached banks of shingle, marked on the map, represent the storm-broken tip. A chart of the time of Henry VIII marks the mouth of Orford Haven as opposite Orford. Since that date the spit has advanced five miles. Judged by the Ordnance Map of 1838, North Weir Point has advanced about a mile in the last 100 years. Just south of Aldeburgh the bank is less than a hundred yards wide, and here once was the outfall of the River Alde. But the sea currents were stronger than the river, so that the sea-bank was extended southwards from the turn of the coast. In so doing it has smoothed the coast outline.

As the beach advanced, it blanketed the mouths of the Rivers Alde and Butley in turn and diverted them southwards. In the storm-protected water behind the barrier, salt-marshes, from Sudbourne Marshes at the root to Oxley Marshes at the tip, and low flat islands, such as Havergate, have been laid down. Much has been reclaimed by embankment and drain (see map), and the low spot-heights show how necessary such embankment is. But that alluviation is not completed is shown by the wide expansion of the Alde, west of Aldeburgh.

The Stage in the Geographical Cycle.—The deeply penetrating articulations of the Orwell and the Stour

stamp this part of the coast as in an early stage. It has changed little since its embayed character was first formed. But Landguard Point has advanced some distance, if a short one, in its struggle with the combined currents of the two rivers. It looks as if it is trying to accomplish what the Orford Beach has already done against the much weaker Alde and Butley. There are signs on the map that the Deben mouth also is being diverted southwards.

While the estuarine section of this coast still remains much as it was, and may indeed, like Peter Pan, never "grow up," the Aldeburgh section has accomplished much work in advancing towards its appropriate curve of equilibrium. It has not only shut in lagoons and ponded back streams into shallow sheets of water, like the Mere and its Fens, but it has seen these filled up behind Minsmer Haven. The small streams at Minsmer Haven and the Mere percolate through enclosing barriers into the sea. This part of the coast, therefore, might be described as in the late stage of its life-cycle.

But instability characterises the whole shore-line. The soft cliffs to the north are continually falling; the old port of Dunwich has disappeared. In spite of groynes the fallen material is picked up by the sea, which is discoloured, is carried along the coast and dropped to form, for instance, Sudbourne and Orford Beaches.

Other Large Scale Illustrations.—Some reference has already been made to spits and lagoons and examples given in dealing with the Rhône Delta (Section IX) and the Kerry Coast (Section XXXII). On the Vesuvius Sheet C. Miseno seems "tied" to Monte di Procida by a double bank, and along the coast to the north is a chain of lagoons, shut in by sand-bars and dunes, some evidently planted with pines. Reference is made later to the Pebble Ridge of Westward Ho! (Section XXXV), and on the Bournemouth Sheet a long sand-bank shuts in Poole Harbour and narrows the ferry.

Atlas Examples.—The shapes of the Mersey and Dee Estuaries should be compared; for whereas the wide-open Dee, once leading to the port of Chester, has been silted up, the Mersey has maintained its depth by tidal scour through its narrowed mouth. The Humber Estuary is sheltered on the north-east by Holderness and the hooked spit that ends in Spurn Head. Blakeney Spit (and lagoon) on the North Norfolk coast is famous as a sanctuary for wild-bird life. Yarmouth is built on southward pointing sands, that have turned the mouth of the Yare for a distance of three miles. Part of Romney Marsh is bordered by a long shingle ridge. Wexford Harbour is shut in by a long bank, projecting from the south. Examples are many, but some references may be made to other lands.

Spits or "nehrungs" enclose Frisches and Kurisches "Haffs" along the Amber Coast of East Prussia. The Coorong bars in Lake Alexandrina and the mouth of the Murray River. Ninety Mile Beach is one of a series of bars along the coast of Gippsland in Eastern Victoria. In New Zealand some of the bays in the north-western arm of North Island are almost enclosed in this way, *e.g.* Manukau and Kaipara Harbours. In the United States a long chain borders the Atlantic and Gulf of Mexico Coasts; Cape Hatteras, like Orfordness, is the point of one. Atlantic City, the Brighton of New York, and Galveston in Texas are built on others. In Lake Ontario Toronto Harbour is so protected.

Reference.—J. A. Steers: *The East Anglian Coast* (Geographical Journal, 1927).

(For the associated human study, see Section XL.)

SECTION XXXV

MARINE DEPOSITION—BEACH AND PROMONTORY

NORTH DEVON

Where roaring on the ledges the summer ground-swell rolled.
KIPLING : *Lukannon.*

The Map.—Ordnance Survey, England—Scale 1/63,360 : Popular Edition, Sheet 118, Barnstaple and Exmoor.

The District Selected.—The sea coast from Westward Ho ! to Ilfracombe.

General Description.—This sheet is part of the coast of North Devon. Ilfracombe is on the north coast ; Barnstaple appears on the east. The Rivers Taw and Torridge converge at Appledore. The sea cuts across the strata and washes blocks of differing resistance. Tough rocks form promontories at Bull, Morte and Baggy Points and at Saunton Down ; re-entrant bays lie between—Morte, Croyde and Barnstaple Bays. The accompanying diagram helps towards understanding the map. The last Section illustrated marine deposition along a low coast ; this section illustrates marine deposition along a high coast.

Westward Ho ! to Saunton Down.—The cliffs of Westward Ho ! are succeeded by a deep and wide re-entrant, triangular in shape, with apex near Barnstaple and base along the sea. It is the largest area of waste on the Devon Coast, " a wide expanse of hazy flats, rich salt marshes and

rolling sandhills, where Torridge joins her sister Taw and both together flow quietly towards the broad surges of the bar and the everlasting thunder of the long Atlantic's swell."

South of the Taw lie Northam Burrows, part turf, part hillocks and hollows of sand. These burrows are shut in by the famous Pebble or Popple Ridge—two miles long,

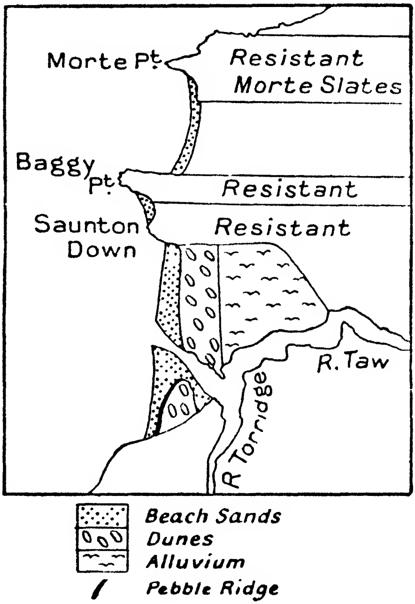

FIG. 38.—NORTH DEVON COAST—GEOLOGICAL PLAN

50 feet broad and nearly 10 feet high. The rolled, oval shingle is driven by waves and currents from the cliffs on the south. The current of the Taw has stopped its northward travel and turned it upstream into the form of a hooked spit. The spit shares in the landward movement common to most of these banks; for it is being slowly rolled over on itself and is invading the levels behind. In one gale in 1896 the shingle ridge moved ten yards inland. As the

cliffs to the south recede under wave attack, so will the ridge become more exposed and be driven further inland.

North of the Taw the recent beds, that fill the re-entrant, are ranged in three belts, Saunton Sands, Braunton Burrows, Braunton Marsh. Saunton Sands have been dropped in the slack water, and the map indicates that they are still covered at high tide. The rolling miles of Braunton Burrows, dunes indriven by prevailing on-shore winds, like the Culbin Sandhills of Section XIII, rise to considerable heights (spot-height, 85 feet); their axes lie north-west to south-east at right angles to the direction of the wind, and much is covered with bents. Like Northam Burrows, they provide the groundwork of a famous golf course. Braunton Marsh has been laid down by the river and the tide and subsequently reclaimed to form rich pasture; the white colour proves its flatness, the spot-heights its nearness to sea-level. The situation of the village is on the firm, dry edge of the old slopes where arable and pasture meet.

Saunton Down to Morte Point.—Resistant beds have stiffened resistance to marine erosion at Saunton Down, Baggy Point and Morte Point. But in each case the work of the waves in trimming back the cliffs has left behind rock ledges of considerable width. The reefs between tide-marks are drawn conspicuous on the exposed Morte Slates, " fields of shark-toothed rocks," the " cruel Morte Slates," black and sinister, to which the illustration on Plate XVA bears ample witness. On them many a ship has beaten out its life. Death Rock does not belie its name; tombstones in Mortehoe churchyard tell of the wrecks of ships, in earlier days often lured to destruction " by errant lights where no light should be."

In the tidal sweep along the coast Baggy Point cuts off the supply of boulder and sand from the south, as also does Morte Point. Thus the quieter waters of the re-entrant bay-heads receive their sands from the destruction of their

southern salients. Croyde Bay is a perfect little hollow, cut back along the junction of two sets of rock. Its short but wide stretch of sand rests at both ends against flat rock-ledges and is backed by dunes and by slopes of Devonshire greenness. The few thatched cottages of the village are set well back on a small stream, which has the strength to turn a mill-wheel, but not to reach the sea across the sands. The map and the illustration (Plate XVB) combined show the long broad stretch of splendidly firm Woolacombe Sands between the rock ledges of Baggy and Morte Points; these sands attract many summer visitors to Woolacombe village.

The Stage in the Geographical Cycle, looked at as a whole, represents maturity. The headlands are being trimmed back, but as yet they protrude a mile or more, and still further in their dangerous reefs. They are still effective in checking alongshore drift. Complementary-wise, Woolacombe and other sand stretches have grown outwards. The whole coast is advancing from an embayed state to the smooth-flowing outline of its appropriate curve of equilibrium.

(For the associated human study, see Section XXXIX.)

SECTION XXXVI

MARINE EROSION—CLIFFS, COVES AND PLATFORMS

THE ISLE OF PURBECK

Till the slow sea rise and the sheer cliffs crumble,
Till terrace and meadow the deep gulfs drink,
Till the strength of the waves of the high tides humble
The fields that lessen, the rocks that shrink.
SWINBURNE : *A Forsaken Garden.*

The Map.—Ordnance Survey, England—Popular Edition: Scale 1/63,360, Sheet 141, Bournemouth and Swanage. In addition, one set of the six-inch sheets would be valuable—Dorsetshire, LV, NW ; LV, SW ; LV, SE ; LIV, NE.

The District Selected.—The coast of the Isle of Purbeck.

General Description.—Ideally, this Section on Marine Erosion should precede illustrations of Marine Deposition. Since this would break into the middle of Section XXXIV, it is placed later for convenience. The geological diagram and section of the Isle of Purbeck show that the strata outcrop in west-east bands ; the dip is at a high angle. The Portland and Purbeck limestones are resistant sufficiently so to be quarried for building stone. Inland they form a high plateau, along the coast a resistant wall. The clays and sands are relatively weak and form the long, interior Vale of Swanage. Behind these the chalk outcrops and forms the Purbeck Ridge, which ends in Ballard Down and the Foreland ; a conspicuous breach at

Corfe Castle guides the road and rail approach to Swanage. On the east and the west the alternating resistant and weak rocks present their edges to the sea. The resistant

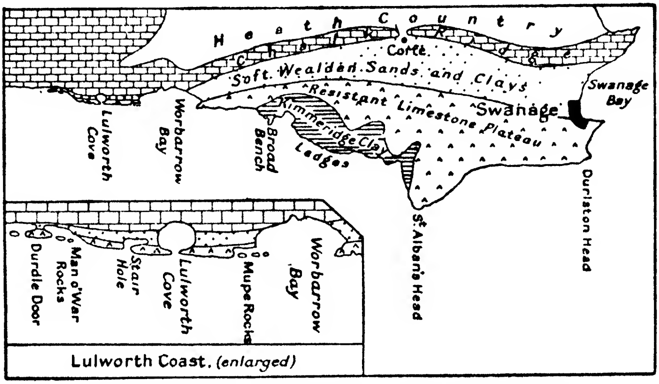

FIG. 39.—ISLE OF PURBECK—GEOLOGICAL PLAN

chalk projects a mile in the Foreland with steep, grey cliffs, 500 feet in height and with detached stacks. The limestones extend into the sea at Peveril Point and the

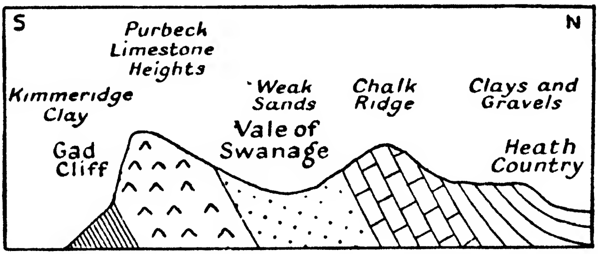

FIG. 40.—ISLE OF PURBECK—GEOLOGICAL SECTION FROM NORTH TO SOUTH

reefs beyond and at Durlston Head, while on the south the spot-heights and the close or abruptly ending contours portray a front of almost unbroken cliffs which plunge directly into the sea. Between the limestone and the

chalk ridges the interior vale ends in wide sweeping bays (Swanage, Worbarrow), the smoothness of whose curves proves the general absence of resistance to the attack of the sea.

The geological diagram shows that the rocks of the Isle of Purbeck are continued westwards, though they have been squeezed into narrower bands. This is partly because the strata become thinner and partly because they dip at a higher angle.

All these features should now be identified and followed, step by step, on the one-inch sheet.

Durlston Head to Gad Cliff.—For long stretches on the south coast of the Isle of Purbeck the limestone wall fronts the sea and has remained intact. There are only two small breaches in the five miles of cliffs between Durlston Head and St. Alban's Head.

But it is the coast to the west of St. Alban's Head that is exceptionally interesting and picturesque. In the five miles between St. Alban's Head and Gad Cliff the Kimmeridge Clay emerges from underneath the Portland and Purbeck Stone in nearly horizontal layers. The Kimmeridge "Clay," named after the village a mile inland, consists of thin layers of alternating tough limestones and weak shales and clays. Since the beds lie nearly horizontally, their edges, hard and soft, are exposed to the aggressive action of the sea, and the result of such action is made plain by the map-symbols and terms for the Kimmeridge Ledges and Broad Bench and, above all, by the view of the latter on Plate XIVB. In the last the Kimmeridge beds appear in the cliffs of the background, to which the sea has cut forward, leaving a wide shore-platform, like a massive pavement, as the mark of its work. The present "bench" or "ledge," however, is not likely to endure for long; for, from the view, it can be seen that in the foreground the sea is attacking the joints, the weak lines in its armour, on the upper surface

of the resistant band. Still more, since the ledge is slightly tilted upwards towards the right, the sea is able here to reach and dig out the soft shales that underlie it. The hard surface band is being undercut and will break off piece by piece as the undermining proceeds. So the whole will eventually be destroyed.

In places the cutting back of the coast cliffs has advanced further and the straight outline is modified by coves like Kimmeridge Bay and Chapman's Pool, apparently where small streams reach the sea. Along this stretch of coast, too, destruction is being helped not only by many fractures, of which, however, the map gives no sign, but by the frequent land-slips of the upper porous Portland rocks over the underlying wet and slippery Kimmeridge clays. The double-stepped cliffs on either side of Chapman's Pool seem to be due to this cause.

Gad Cliff to Durdle Door.—Further west still, in the five miles between Gad Cliff and Durdle Door, are illuminating illustrations of all stages of destruction by marine erosion. The soft Kimmeridge rocks do not appear here. They are replaced at the sea-front by tough Portland and Purbeck Limestones, tilted at a high angle; these rocks present, as it were, a solid back to the waves. They can be seen to extend, as a narrow band, to east and west of the entrance to Lulworth Cove, and to their resistance is due the narrow width of the doorway. For a mile east of Lulworth the limestone wall has so far remained unbroken. The first stage in its disruption is seen in Stair Hole. This is not named on the Ordnance Survey Map, but it lies 200 yards west of Lulworth Cove and just south of the word "Inn." If the one-inch scale is too small to define it clearly, the view on Plate XIIIA comes to our aid. The observer is looking eastwards. Working through the clear-cut joints, the sea has bored two tunnels in the limestone rampart, through which it surges in and out without cessation. The roof of a third has fallen in

and now forms the complete breach at the foot of the observer. So the sea has gained access to the weak rocks behind the screen, and the soft sands and clays are being rapidly scoured out. An oval hollow has been formed with a shingly and rocky floor, shut in seawards by the remnant of the limestone wall.

The next stage of destruction appears in Lulworth Cove. Here the rampart has been fairly broken down in a narrow opening, and the hollow behind has been naturally enlarged into a circular harbour about a quarter of a mile in diameter. It is large enough to be clear on the map, and the air-view (Plate XIIIB) sets off the beauty of its symmetry. The slightly oval shape is due to the fact that the sea has reached the resistant chalk on the northern side and its progress is here checked; but the harbour is being enlarged to west and east along the weaker beds, as in Stair Hole.

A still more advanced stage is illustrated in Mupe and Worbarrow Bays further east. A comparison of the map and the photograph (Plate XIVA) shows how the limestone "wall" has been demolished for a mile and a half. The Mupe Rocks are its relics. The inner beds have been cleared, until now grey chalk forms the northern margin, where abruptly ending contours tell of precipitous cliffs, up to 500 feet in height at Rings Hill and Bindon Hill. Similar destruction has produced St. Oswald's Bay to the west, where the blunt-headed protuberance marks the dying remains of the "wall" here; Durdle Door is a tunnel, like those at Stair Hole, but enlarged into the form of a natural arch, and the two wings of the protuberance extend east and west as half-tide rocks, whose names—Man o' War Rocks, The Bull, The Blind Cow and so on—do not appear on the map; they may, or may no longer, resemble their descriptive titles.

The chalk itself, however, yields in time. In the Foreland, north of Swanage, caves have been bored, and pillars of chalk have been isolated by the sea. Old Harry stands detached from the cliff, and a much larger mass,

now connected only by a narrow neck, will soon be severed. Old Harry's Wife was destroyed by the sea in 1896.

Other Large Scale Illustrations.—A relief model of the Isle of Purbeck, geologically coloured, is on view in the Geological Museum in Jermyn Street, London, and should be seen by anyone who has the opportunity.

Reference.—*Guide to the Geological Model of the Isle of Purbeck,* Geological Survey, price 6d.

(For the associated human study, see Section XXXVII.

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PART VI

COAST LIFE

SECTION XXXVII

SEA-SHUNNING SETTLEMENT—COAST HAMLETS

SCOTTISH CROFTERS AND OTHERS

I ploughed the land with horses,
But my heart was ill at ease,
For the old seafaring men
Came to me now and then
With their Sagas of the Seas.
LONGFELLOW : *The Discoverer of the North Cape.*

The Maps and the Districts Selected.—Swanage and Oban Sheets, as for Sections XXXVI and XXXI.

Introductory.—Strictly speaking, the heading of this section would apply to the whole of Part VI ; for no community can be described as " sea-seeking " any more than a mining population is to be supposed to seek for choice the bowels of the earth. Nothing but economic pressure drove men " to have their business in great waters." The Greeks, the earliest seafaring community known to us at all intimately, dreaded the sea ; the Romans hated it ; the Phoenicians followed it against all the natural instinct of the Semites ; and we do not find that our own Saxon ancestors showed much inclination to repeat the experience that brought them to these shores. So long as Man can win a livelihood from the soil, to the soil he clings ; and when he is pushed off the land, his traffic with the sea is confined to extracting fish with all possible dispatch or getting ashore elsewhere in quest of something his own land cannot offer. This is not to deny

that familiarity in time may breed tolerance or even, in certain natures, zest for its rare delights and frequent dangers. Such was the spirit that animated the Norsemen, whose domination of the Atlantic seaboard of Europe was largely responsible for the reluctance of the later Saxons to venture afloat.

These Vikings or Wicings (men of the *wics* or creeks), impelled by poverty or dispossession, made a virtue of the necessity that drove them from their forest-covered plateau to the easier plundering of more favoured lands, and grew to love the " sea-way " as much for its own fierce joys as for the booty and the battle-thrills to which it carried them :

> And the men out pushed
> Their tight ocean-wood on adventure long desired.
> Swiftly went above the waves, with a wind well fitted,
> Likest to a fowl, their Floater, with the foam around
> its throat.

And honour accrued to him, says the old Norse saga, " that never slept under sooty beam and never drank in chimney corner."

When they passed, they left behind them, in their own fiords and in their Norman colony, a tradition of seamanship which has been matched by no European stock but the British, who in part, at least, must be reckoned their descendants, and the Bretons, themselves " men of the creeks " in all but name.

It is from inshore fisheries that deep-sea adventurers are in the main recruited, and no country, except Japan and North-eastern America, dips its nets into such inexhaustible wealth as swims off the British coasts. British seamen first began to earn a name in the days of the Third Crusade ; in the sixteenth century our fishermen were harrying the cod of Iceland and the Grand Banks, and acquiring the taste for distant voyages that made the age of Queen Elizabeth so remarkable. Elsewhere, we may find neighbouring coast populations facing opposite ways—

the one, with no temptation to desert the solid land, devoting itself wholly to the soil; the other driven by scanty terrestrial resources and drawn by sheltered havens to seek a living from the sea. Such contrasts were displayed by the Philistine husbandmen and the Phoenician traders of ancient Palestine and by the Virginian planters and the New England seamen of the colonial era, and are displayed by the Danish dairy farmers and the Norwegian fishermen of the present day. In our comparatively limited and homogeneous islands, where every cove and strand has contributed its share of the crews that have made our history, it is not easy to find a population that shuns the sea with camel-like consistency. We may, however, select two districts; in the one a cliff-bound coast turns men's eyes inland notwithstanding the unattractiveness of infertile soils, and in the other economic circumstances rather unexpectedly confine the contact with the sea within the narrowest limits.

THE SOUTH COAST OF THE ISLE OF PURBECK

The Sea Approach.—The south coast of the Isle of Purbeck has already been described in Section XXXVI. The features, relevant to present considerations, are: an unbroken line of cliffs from Durlston Head to St. Alban's Head; a belt marked by bays and rocky shelving ledges from the latter to Broad Bench; and thence a coast of cliffs and coves. Of all the bays and coves it will be noted that, with the exception of the one at Lulworth, the mouths lie wide open to the prevailing south-westerly gales. They do not offer protected harbours; and the entry to each, as the ledges hint, is shallow and evil-looking. Lulworth Cove alone is deep enough for pleasure steamers to push their bows up to the shingly beach. The sea approach is not attractive.

The Land Approach.—Access to the shore-line from the

landward side is shown by the map to be no easier. Here and there a small stream has cut a way down, only to end in steep descents. Nor is the Channel visited by those great schools of herring that draw the fishing fleets out of east-coast harbours from Wick to Lowestoft. The sea here is barren, except for lobsters, which alone maintain a handful of part-time fishermen here and there. Examine the whole length of coast from Swanage round to Lulworth, and, apart from a single lonely cottage at Winspit and one or two tiny clusters, where small brooks end at Kimmeridge and Worbarrow Bays, there is no sign of human habitation, except for the lighthouse on Anvil Point and two coastguard stations. The pier in Kimmeridge Bay is one by courtesy only; for it is merely a short slip of stone to which a rowing boat can tie up.

Inland Settlement.—The villages of the plateau—Langton Matravers, Worth, Kimmeridge and Kingston (H, 6)—are set well back from the sea, a mile or more, and no road, not even a cart track, leads down to the water's edge. Even at Lulworth the church and village are the best part of a mile inland, although an offshoot has been thrown out lower down. But the colour of the road approach, extending as it does from the main Dorchester-Wareham road, is a sign of the tourist and holiday-maker in car and motor-coach, attracted by the picturesqueness of the cove, rather than of busy fishing. All evidence combines to emphasise a coast of repulsion to the native, if not to the student of marine erosion and to the summer visitor.

Exposed coast and barren sea turn the faces of the permanent inhabitants inland to the quarries and to the soils of the Isle of Purbeck. Purbeck Stone finds a place in many a church, house and cottage in the south, but neither the Purbeck and Portland Rock of the plateau, nor the Wealden Beds of the Vale of Swanage, nor the Chalk Ridge yield bountiful harvests or rich grasses; the countryside nowhere presents an appearance of fertility.

The villages, whether on the limestone plateau or in the Vale of Swanage, are quite small. They are isolated and far apart. Roads are few and far between. Tyneham, Steeple and Church Knowle in the western half of the vale are tiny hamlets, as are Worth, Kimmeridge and Kingston of the plateau. In the eastern half of the vale, except for Corfe Castle, there is no hamlet at all. And, although Corfe Castle appears as a focus of ways passing through the chalk ridge and may be the provisioning centre of a considerable neighbourhood, yet one may not be without some justification in feeling that its picturesque position has much to do with its exceptional size. A twofold ring of contours makes its castle ruin, the old guardian of the pass, stand up on the hill-top between the two transverse trenches that form its double gap. And, beneath, the village itself, a "symphony in grey," affords an old-world air of peaceful stability by reason of its low stone cottages, its solid gables and dormer windows and its heavy slab roofs—within a few miles of Swanage and the sea. Its call is strong to artists and other visitors. Langton Matravers on its steep slope at the opposite side of the vale also looks a long-drawn-out, but considerable, village. The map would make one naturally associate some of its life with the quarries that lie close by, but gives no sign that its vigour is refreshed by the presence of a number of preparatory schools for which this exceptionally healthy corner of Dorset is admirably adapted.

THE WEST COAST OF ARGYLL

General Description.—The physical features which at once attract the eye are the background of moor and glen, and the sea-front of islands and sheltered channels. The deeply penetrating sea-lochs seem to unite land and sea. With a background repellent to cultivation and a sea-front apparently inviting seamanship, one might expect a race

of sailors; and the frequent recurrence of "Port" in seaside village names points in the same direction. Yet men here turn their backs to the water; life is based on a struggle with scanty soils and heavy rainfall, and, still more, on serving the needs of tourists and wealthy sportsmen.

Upper Loch Etive and its Glens.—The central turn of the coast at Taynuilt and Bonawe divides the loch. Above, it is narrow and steep-sided to the water's edge, as the map and the illustration (Plate XIIB) prove. The view is taken from near Taynuilt, looking up the loch. Below the turn the hills are less high, the slopes are less steep and a raised beach offers a flat shelf for Taynuilt and the railway to Oban. The upper reach possesses few buildings of any kind; there is no alongshore road, nothing but a footpath. At wide intervals an isolated gamekeeper's cottage or shepherd's hut is marked upon the map, where some side valley opens to the water—at Ardmaddy, Glennoe or Dail. One may wonder how many children attend the lonely school on the western bank, or how they reach it in winter.

In autumn the region may waken into life with the advent of the sportsman. A shooting-lodge is marked near the head of Kinglass, approached from the north-east over a rough road, and doubtless other large groups of buildings, which have roads leading to them, are similarly inhabited for the season. At the head or along the shores of the loch a few piers, at which the footpath becomes a track, suggest contacts by motor-launch; such may be found at Gualachulain and Barrs.

Lower Loch Etive and the Coast.—Below or west of Taynuilt dwellings are more frequent. Their distribution over the area clearly follows the low ground. The high land is without cottage or road, abandoned to rough, mountain pasture; in the Highlands sheep-walk, grouse moor, deer

forest ascend the slopes in that order. Along the glens, beside the loch or near the sea thin lines of cottages or small hamlets seek shelter and patches of cultivable soil. Where the Pass of Brander reaches Loch Etive a considerable village has arisen at Taynuilt, some way inland. But neighbouring Bonawe seems to lead to the water and its ferry. Perhaps the slate quarries on the opposite shore are the cause. Taynuilt itself, half a mile back, where three main roads meet, would appear to be the local centre. Boasting a station, telegraph office and two churches of different denominations, it seems the natural focus of a farming population, among whom sheep and fodder crops that can mature under cloudy skies will demand attention, though the hotel speaks of temporary interests in the tourist industry of the summer season.

West of Taynuilt the main road and the railway lead to Connel Ferry and Oban. Its fenced character means crops or animals, or both. Connel Ferry repeats Taynuilt, a gathering place at the loch-crossing and a centre for the holiday-maker. On the north side Kiel Crofts along the margin of the untenanted Moss of Achnacree, matched by others two miles to the north-west, again hints at activities related to the land.

There has been little to suggest a seafaring people, and a glance over a wider area of the coast and its islands only confirms the impression. Roads are mostly set back away from the sea margin. Here and there a small hamlet is found close to the water, sometimes on the level bench of a raised sea-beach. Notwithstanding the "Port" in hamlet names, *e.g.* on the island of Lismore, there is hardly anything on the ground but a few small boats drawn up on the beach, or here and there a small pier on the map, to suggest contact with the sea. Once the coast saw fishing-boats on its sheltered waters, revived for a time during the Great War, but the demands of an inland industrial population for a perishable food has created the fishing fleet on mass

production lines and drawn off the fishermen from coast villages to a concentration in a few great harbours; the fishing base on this coast is Mallaig. But the west coast of Scotland and its difficult mountain setting turn their backs, as it were, on the densely peopled lowlands of Scotland and England and look out across protected inner waterways, it is true, but to the stormy Atlantic beyond. Its villages and hamlets contrast, therefore, with some that still survive on the east coast, say, of Yorkshire.

Once the Norsemen sailed down the coast from Scandinavia, and from the island bases raided the mainland, but do not seem to have settled there, as they did in the Lake Dome. According to a map in Isaac Taylor's *Words and Places*, while many names of bays, lakes and islands are Scandinavian in the Western Isles, those on the mainland are almost wholly Celtic.

SECTION XXXVIII

SEA-SEEKING SETTLEMENT—FISHING VILLAGES

DALMATIAN MARINERS

Over the mountains aloft ran a rush and a roll and a roaring ;
Downward the breeze came indignant and leapt with a howl at
the water ;
Crashing and lapping of waters and sighing and tossing of weed-
beds,
Gurgle and whisper and hiss of the foam, while thundering surges
Boomed in the wave-worn halls, as they champed at the roots of the
mountain.

KINGSLEY : *Andromeda.*

The Map and the District Selected.—As for Section XXXIII, Zara.

General Description.—The fundamental fact, already described, is a narrow coast zone of low islands, channels and peninsulas, cut off from the interior by a solid mountain wall.

The Coast Zone.—In some ways the Zara Sheet affords the best example of sea-seeking settlement on this series of maps. The high mountain barrier not only cuts off the Adriatic from the interior but offers little more than steep limestone slopes, destitute of superficial water and of soils, bare and unproductive. On the other hand a narrow littoral of lower, banded peninsulas and a triple fringe of islands afford some footholds for the stippled gardens, orchards and vineyards of the map and many deep, sheltered channels as nurseries of seamanship. The

bare, unproductive interior repels; the sea and its protected sea-ways attract. No railway penetrates the interior on this sheet; only one road crosses—from Obbrovazzo to Lovinac—and its twists and turns imply difficult gradients, increased mileage and engineering problems. Nor does any road run along the coast. We may conclude that the most important routes are by water. Some 10,000 boats are engaged in carrying the local traffic of the Dalmatian coast. Some 26,000 Dalmatians "go down to the sea in ships," of whom half are fishermen. And the bora, that violent down-blowing wind that lashes parts of the Eastern Adriatic, as its fellow, the mistral, sweeps Provence, provides that spice of difficulty and sudden danger that makes of the Dalmatians the best sailors of the Mediterranean. Some islands show a close packing of dwellings, roads and gardens near the sea. On the mainland the only settlements that are worthy of emphasised type are by the sea-board. Zara alone, the sea focus of a fan-shaped road scheme inherited from Rome, reaches block capitals.

Oversea Contacts.—The sea-contacts are emphasised in another fashion. The village names on the map, especially on the mainland, are Slav; the islands and channels are largely Latin. Although Dalmatia was colonised overland by Slav immigrants, who still form the bulk of both the rural peasantry and the maritime elements of her population, and although it was for long years under the dominion of the Turkish and Austrian Empires, its contacts by the seaways of the Adriatic brought contributions from Rome, Venice and Italy. At the present time, Italians form large blocks in the towns. Zara especially is a stronghold of Italian art and architecture, language, education and professional skill. Zara, in fact, is the chief cultural centre, as Spalato is of maritime commerce. Thanks to the sea, Dalmatia is developing her material contribution to the world from sardine fisheries, fruits and wines — Maraschino di Zara

is made from the Marascha cherry—and has recently added cement and other products from her limestones.

Dalmatian Pirates.—Piracy, a scourge endemic in the Mediterranean for at least three thousand years and only really banished in the nineteenth century, had many repairs, but in the third century B.C. it was the Illyrians who made themselves most dangerous. From their secluded harbours Dalmatian pirates issued to ravage the coasts of Greece and Italy and prey upon the commerce of the Adriatic, while the intricate channels among their native islands enabled them to laugh at all pursuers. It took two wars, waged with all Rome's naval resources, to destroy their nests and reduce their rulers to submission, and the menace was never really removed till the opening years of the Christian era. A thousand years later still we find the city state of Venice earning the gratitude of both the Byzantine and the Holy Roman Empires for suppressing Dalmatian piracy, which had reared its head once more with the decline of a central government. Centuries of bitter memories lie behind recent Italian annexations among the Dalmatian islands.

Other Large Scale and Atlas Illustrations.—The nearest structural parallel on this series of maps is in Southern Ireland. The double basin and narrow transverse entries of Cork Harbour give the protected basins, which are so frequent a feature in Dalmatia. And the fishing population is, to some extent, a parallel.

SECTION XXXIX

SEA-SEEKING SETTLEMENT—THE LOCAL HAVEN

MEN OF DEVON

It is to the sea-life and labour of Bideford and Dartmouth and Topsham and Plymouth and many another little western town, that England owes the foundation of her naval and commercial glory. It was the men of Devon, the Drakes and Hawkins, Gilberts and Raleighs, Grenvilles and Oxenhams, and a host more . . . to whom she owes her commerce, her colonies, her very existence.

KINGSLEY : *Westward Ho!*

The Map and the District Selected.—The coast of North Devon, as for Section XXXV.

General Description.—The capital facts in the relief of the district are the west-east setting of the rock-bands, which differ in their powers of resistance. Along the north the tough Ilfracombe Beds and Morte Slates present a uniformly rocky front; on the west their ends, cut across by the sea, project in bold promontories or withdraw into beach-lined bays in harmony with their rock-fibre. The Taw and the Torridge, united in a single stream, pierce the mud-flats, burrows and sand-beach in the " silver estuary " of Charles Kingsley.

Bideford, Appledore and Instow.—To the Englishman the name Devon immediately conjures up visions of Elizabethan days, when Sir Francis Drake played bowls on Plymouth Hoe and fought the Armada, when John Oxenham—and Amyas Leigh—trod the cobbled quay at

Bideford, and when Sir Richard Grenville fought the *Revenge* to the death. The days are past when North Devon sent ships to join the Armada and when vessels from Newfoundland and Virginia unloaded cod and tobacco on her quays. But their memory is still enshrined along the river and, although eclipsed by the great ocean ports of modern days, Bideford, Appledore and Instow preserve in a quiet way their interest in shipping (Plate XVIA). Up till fifty years ago ships of 500 tons were built at Bideford. Instow shows a quay and pier on the map, and Appledore still builds and repairs small craft; the lifeboat station on the map suggests that fishermen are still there to form the crew. The lighthouse and buoyed approach mean seafaring activities, as the tide runs up and down the double river. The mud-flats of the map call up a picture of ships and boats canted at all angles as they rest on the mud at low tide. The alongshore plan of all three towns adds further strength to the suggestions, though Bideford Quay, below the many-arched bridge, is now a broad, tree-lined promenade. All three seem to rise steeply from the water's edge—several contours pass through each—and, like those of most old ports, their streets are likely to be narrow and tortuous. We may think of coasting vessels bringing coal, cement and wood or other heavy cargoes for local use, in which regard we note that they are served only by a local single line. The semi-circular line from Appledore to Bideford past Westward Ho! is now disused, and Westward Ho! itself, a gathering of modern buildings, belies its name; it has never summoned its people to adventures on the Atlantic, and its visitors belong to the modern type of sea-seekers who find health and excitement on the links of a seaside golf course.

The Western Promontories and Bays.—Along the western shore-line, village sites are some way up the valleys which open seawards; such are Georgeham and Croyde. Morte-

hoe also is well back on its hill-slope, although it seems to have expanded downhill. Woolacombe is separated from the sea by a wide strip of sand and, moreover, looks overgrown for its surroundings. It would seem that the outlook of these villages is towards the neighbouring fields and the activities associated with them. Woolacombe is laid out "according to plan" rather than in the irregular form of a rural village; and this would make one tentatively link it with the amenities of a summer-holiday resort rather than with either farm life or a seafaring livelihood. In fact, all the villages here, Woolacombe excepted, seem to turn their back to the sea so far as their permanent interests are concerned.

The Northern Shore Line, presenting as it does a solid wall to the sea, is only settled in the sheltered notches due to ravines, and even so the hamlets are placed some way inland and are cut off from the water by rocky shore-platforms. Ilfracombe alone looks seawards, but its size is evidently out of keeping with merely local needs, and we look for evidence of relations more remote. Its broad sea frontage, its artificial Torrs Walks and its golf links stamp it as one of the holiday resorts for which North Devon is far-famed. And, if we look for additional evidence, the double-line railway and the direct convergence on the town of three main roads, which leave villages on one side, seem to supply it. The harbour, under the lee of Capstone Point and its rocky peninsula, (spot-height, 156 feet) indicates old sea contacts, but the character of the town, suggested above, justifies the assumption that South Welsh colliers and excursion steamers from the other pleasure resorts of the Severn Estuary make most use of it.

SECTION XL

SEA-SEEKING SETTLEMENT—PACKET STATION AND NAVAL BASE

BRITISH SEAMEN

But of his craft to reckon well the tides,
His streames[1] and his dangers him besides,
His harborough and his moon, his lodemenage,[1]
There was none such from Hulle to Cartage.
CHAUCER : *The Shipman.*

The Map and the District.—As for Section XXXIV, part of the Suffolk and Essex coast.

General Description.—The type of coast, whether low or high, embayed or straight, remote or near, exerts its natural influence on the conditions of settlement and the grip of the sea. Here is a gently sloping lowland of faint relief, covered by a superficial mantle of rich drift soils. On the seaward margin the plain is edged either by a line of low crumbling cliffs and shallow water or by a barrier of amphibious country, marshy flats and mud, in part reclaimed. Only where the deep, straight estuaries of the Stour, the Orwell and the Deben penetrate, is the barrier of cliffs, marshes and shallows pierced. Here then sea-life is likely to be focussed.

The Deben and the Orwell Estuaries.—Map-signs lead the tidal ebb and flow of the two rivers as far as Woodbridge and Ipswich. The river-beds alternate between

[1] Streames, currents ; lodemenage, steersmanship.

mud-flats and wide sheets of water; their currents have a daily rhythm up and down. On the Deben the wharf and the quay, shown as accessible at high tide, mean something of small shipping—big-sailed barges and other craft of the Narrow Seas—moving in and out with the tide, although the rural aspect of the country evidently imposes restrictions on the total amount of tonnage. The deeper Orwell, the greater population of Ipswich, and the "dock" there imply a heavier and more active movement; it draws from as far afield as the Pacific. Both rivers are disciplined between embankments for considerable distances along critical stretches.

The River Stour and Parkeston Quay.—The creeks and mud-flats of the map take the Stour estuary up to Manningtree and the railway crossing; high tide brings a sheet of water a mile in width. But, for the most part, life along its flanks is unrelated to the river. Villages and roads are set well back, and only a lane here and there comes down to the brink. But in the more permanent depths lower down, Parkeston Quay and Harwich Harbour have active associations with the estuary and its approaches.

The breadth of the estuaries pushes the main line of the London and North-Eastern Railway above the points where the broadening begins. From the bridge towns at their heads a series of branch lines reach out to the coast, and of these the double track of the Harwich line from Manningtree is indicative of something exceptional here. Although Harwich has sent travellers across the seas for more than a hundred years, the map makes Parkeston Quay and its attached rectangular settlement look a deliberate and modern creation by outside forces. The old direct railway route to Harwich is abandoned, and a curve has been thrown northward across the marshes to reach deep water, where now stand Parkeston Quay and its extensive sidings. Fast steamers, carrying men, mails and cargoes, daily cross between here and Esbjerg, Antwerp

and the Hook of Holland, guided by lightship, lighthouse and beaconed channel off the Stour outfall.

Harwich and Landguard Point.—Harwich, judged by the map, is a different place. Everything points to a strongly fortified naval base, facing across the narrow seas. Fort, barracks and rifle ranges on Landguard Point (significant name !) are the present-day successors of the Martello towers marked along the coast, reminders of anxious vigilance in the Napoleonic Wars. On the south side redoubt and battery accentuate the strategic importance of this estuary in a coast which is almost inaccessible from the Humber to the Thames. There are naval barracks and a naval hospital at Shotley in the angle between the two estuaries, and the three stations are apparently in close touch, to judge from the three piers named.

Felixstowe.—To sea-seeking Harwich and Parkeston there remains to be added Felixstowe, the whole attitude of which suggests the summer seaside resort. Its large size, out of keeping with the rural aspect of its surroundings, its elongated plan along the sea-front, the single-line branch railway by which it is approached, and, above all, the pier stamp it as something apart. Perhaps, too, we may look a mile away and inland to the little hamlet of Old Felixstowe and its country church as the predecessor of an urban exotic in which lodging-house keeping is the principal industry to draw sea-seekers of a different kind.

Summary.—The map, as a whole—its close-set mosaic of villages, mansions and farms, its fine-spun web of roads and lanes—has the aspect of an intensive " productive occupation " of the soil rather than a seaward outlook. Part-time fishermen, no doubt, there are still in some of the coast villages, and it may be that the dual life among

such fishermen-gardeners is epitomised in the sign of the "Plough and Sail" at Aldeburgh at the root of Orford Beach. But this estuarine corner of Essex and Suffolk savours strongly of alien intrusions, external relationships and national interests. Bideford seems in keeping with its homeland, a natural growth redolent of Devon. By the side of it, Parkeston, Harwich and Felixstowe seem artificial creations; the sea-seekers come from outside.

SECTION XLI

SEA-SEEKING SETTLEMENT—THE OCEAN PORT

THE MERSEYSIDE CONURBATION

A mighty mass of brick and smoke and shipping,
    Dirty and dusky, but as wide as eye
Could reach, with here and there a sail just skipping
    In sight, then lost amidst the forestry.

BYRON : *Don Juan.*

The Map.—Ordnance Survey, England—Scale 1/63,360 : Popular Edition, Sheet 35, Liverpool and District.

The District Selected.—The western half of the sheet.

General Description.—Packed along the two sides of the Lower Mersey Estuary is an immense mass of humanity, numbering one and a quarter millions. The map shows that on the east or Lancashire side the urban population extends nearly fifteen miles from Garston in the south to Great Crosby in the north, and that its inland boundary is the arc of a circle, some four miles inland at its greatest depth. Within these limits are joined together, in one great assemblage of buildings and traffic, Liverpool, Garston, Bootle, Litherland, Waterloo with Seaforth, and Great Crosby. On the west or Cheshire side are Birkenhead and Wallasey, separated by Wallasey Pool, which was once matched on the eastern side by Liver-Pool,[1] now built over.

[1] Liver-Pool. The Liver is pronounced with a long i. Its meaning is unknown, but is thought to be the name of a sea-bird. In the name Liverpool, of course, the i is pronounced short.

This great conurbation has an exceptional feature in the broad slash of the Mersey Estuary across its centre, a health-giving open space, nearly a mile in width, even if it is something of a check to the intimacy of necessary relations. But the interdependence and closeness of contact of the two sides is made clear on the map, not only by the under-Mersey railway tunnel and the convergence of the Liverpool street system on the water-front, but by the five passenger and two vehicular steam ferries that converge on the Liverpool "Landing Stage," from Woodside, Rock Ferry, Seacombe, Egremont and New Brighton. Some idea of the value of these ferries may be gathered from the following two facts. They transferred from one side to the other over forty million passengers in the year 1927, an average rate of 120,000 a day. The shorter ferries run at ten-minute intervals from dawn to midnight, and they continue through the night at hourly intervals. The closeness of contact will be increased when the new road tunnel, now in process of construction, is completed.

The air-view on Plate XVB looks down from above the river towards Liverpool Landing Stage and its covered approaches. The convergence of the street system on this point is patent, and, even if it were not, the number of trams, gathered just behind, would indicate the fact. The three large buildings in the centre are, in order from left to right: the Liver Building (business offices) with the sea-bird crowning the clock-tower, the Cunard Steamship Company's headquarters and those of the Dock Board. Three ferry-boats are at the landing stage, and two more are steaming hard for it.

Our attention will be confined to the eastern side, and here the city itself may be pictured as a water-front of docks and warehouses, enclosed by an arc of shops and business houses, in the middle of which is the civic heart comprising the town hall, railway stations, hotels, theatres, galleries, and tram and bus centres. Outside this lie the poorer residential and shopping quarters, and outside

this again the better-class homes and the workshops of non-noxious manufactures, such as foods and domestic necessaries.

The conurbation, however, is only the nerve centre of a greater complex organism; for it reaches out over a still wider area and is related to the Atlantic and the river, to the countryside and inland towns.

The Port.—Perhaps the most distinctive feature of the map is the dock-lined front on the Liverpool side; the docks themselves seem to increase in size and, we may assume, in depth seawards. They lie in three groups: riverside Liverpool-Bootle, canal-side along the Leeds and Liverpool Canal, and the isolated group at Garston to the south. This great system, extending without a break for six miles, is skirted behind by a flanking roadway and overhead electric railway along its whole length, with stations every half mile. The map shows some of the hundred miles of dockside railway lines, linked with the main inland lines; they are most easily read at the northern and southern ends behind the North Wall Lighthouse and at Garston, but a close search will reveal others as well as the quayside warehouses with storage for half a million tons.

There is no indication on the map of the world-wide connections of the port, though "Canada Dock" suggests at least one important set of commercial relations. Nor is there any clue on the map to the immense variety of the cargoes with which it deals. The map does suggest, however, that the navigation of the winding approaches to the Crosby Channel are not simple. The Great Barbo and Taylor's Banks, together with the revetment (breastwork) against the latter, hint that the deep-water channel within the discontinuous five-fathom line of submarine contours is liable to shift and needs dredging; it has been carefully buoyed and beaconed for the fifteen miles out to the Bar Lightship. And this is notwithstanding the

scour produced by the narrow neck of the estuary, a scour increased by the still further narrowing through the reclaimed lands of the alongshore dock system.

It is well known that in earlier times Liverpool as a port was overshadowed by Chester, now silted up. Further, this side of England turned its back on the active commercial frontier towards Europe and looked towards the west. Its first interests lay with the comparatively small Irish trade; it derived further wealth as the centre of the slave trade. The connections with both Ireland and West Africa are still maintained; for Ireland is the chief source of Liverpool's meat supply, and West Africa ships oil from its palm forests for the margarine and soap works of the city. The number of West African negroes, too, brought by the connections of the Elder Dempster Line, creates no small social problem. West Indian links also remain in the sugar refineries of the port and in the sweet and jam factories which these feed.

Industrial Liverpool.—Modern growth opened with the Industrial Revolution, the development of South Lancashire as a cotton mill and of the United States as a cotton plantation and food producer. This western link has made of Liverpool the largest flour-milling centre in Europe and the second largest in the world, and, with other towns of the estuary (Runcorn and Warrington), the chief tannery region of the British Isles. And we should link the tanneries, the soap and margarine works, the bleaching and dyeing needs of the cotton industry and the demands of scientific agriculture with the immense chemical works of Widnes (on the estuary, at the south-east corner of the map) and North Cheshire. Its life and facilities as a port imply ship-building and ship-repairing, as well as marine engineering.

So Liverpool, like other ports of entry, adds great industries to her transport functions. These industries may be grouped under three heads: (*a*) those connected

with the importation of products, like wheat and oil, whose bulk may be reduced without great fuel requirements, (*b*) those linked with the coal and iron near by and with the hereditary skill of her people—ships, engineering, (*c*) those demanded by a large and concentrated market which we may call domestic in type and which include foods, furniture and clothing.

None the less the main function remains concerned with transport, finance and business, which employ 35 per cent. of her male occupied population.

Road Congestion.—It will be noticed that no less than nine railway lines and ten main roads, " fit for fast traffic," converge on the civic centre of Liverpool near Lime Street and Central Stations, on the landing stage and on the docks. They enter from all sides—from Southport, Preston and the Ribble weaving towns on the north, from coal-mining Wigan on the north-east, from the circle of South Lancashire spinning-towns round Manchester on the east, and from the Cheshire Gate and North Wales on the south via Warrington. Up till 1900 the main carriers were the railways, which not only left the roads comparatively free, but preserved the satellite towns separate and spaced out round the railway stations. But the coming of the motor-car, the motor-bus and the motor-lorry has produced a revolution. For not only do they congest the roads, but they have made possible " ribbon development," one house deep, which is hastening the coalescence of the towns and villages by the apparent obliteration of the intervening open country.

The growth of road traffic is illustrated by two road censuses. In 1913 on the Liverpool-Warrington-Manchester road the number of vehicles that passed in 24 hours was only 400 ; in 1928 the figure reached over 4000. The Southport road showed a similar increase, though the tonnage on the Warrington road was greater than on all the others combined. Growth and congestion is further

emphasised in other ways. In 1921, 83,000 tons of goods passed from the docks by road; in 1927 the figure was 871,000 tons. While in the railway era all the raw cotton was delivered from the docks by rail, now three-quarters goes by road and only one-quarter by rail. In fact, the situation as to road congestion is summed up in the statement that the outward traffic (in tons) by road equals that by rail, canal, and sea combined.

The Inland Background of the conurbation on its eastern side offers on the map three hints of intimate relationships —those with neighbouring industrial towns, with dormitory towns and villages, and with the farming countryside.

A reading of the contour lines and the spot-heights reveals a western half, west of a line from Ormskirk to Knowsley Park, as a lowland under 100 feet; it is separated into two by a wedge of low-lying mosses (Halsall Moss, Plex Moss) and alluvial flats (River Alt), stretching from the northern edge of the map southwards to Aintree. The eastern half is higher, mainly over 100 feet, rising in high-level "islands" to over 500 feet between St. Helens and Prescot. In the centre of this eastern half a number of mosses are conspicuous, higher lying than the western series, but obviously ill-drained (Bickerstaffe, Simonswood, Kirkby and Reed's Mosses to the west of the St. Helens-Ormskirk road, and Holland and Holiday Mosses to the east). The higher ground of the east is, as might be expected, of more resistant rocks belonging to the Carboniferous series and to the New Red Sandstone, beneath which the Carboniferous rocks dip southwards. It is interesting to note that Liverpool Cathedral is being built of the New Red Sandstone from local quarries, under local direction and by local labour.

Industrial Satellites are those urban workshops which, though closely linked with the conurbation, are yet sufficiently separated by open rural spaces to maintain

their own individuality and their own urban government. Such are St. Helens, Prescot and Skelmersdale (seven miles north-north-west of St. Helens); and to the nature of their industries the map gives some clues. Round St. Helens are marked collieries and glassworks. These stamp

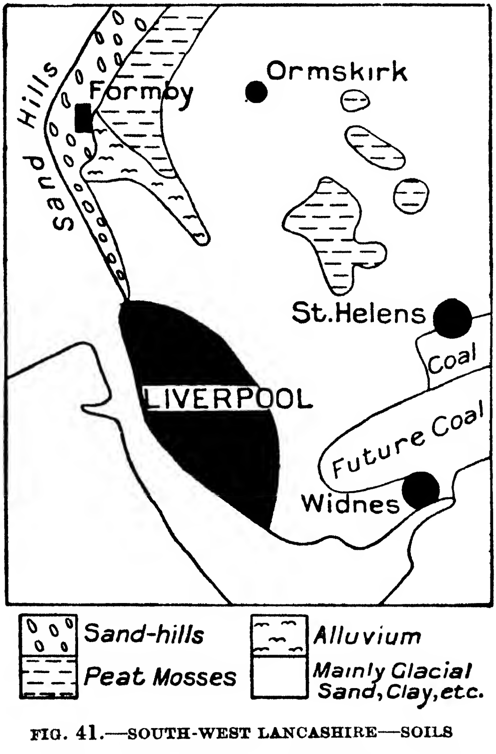


FIG. 41.—SOUTH-WEST LANCASHIRE—SOILS

it as a manufacturing town, and unfortunately we shall not be far wrong in thinking of it as one whose pleasant surroundings have been ruined, at least on three sides, by the repellent desolation of coal-tips, sand-beds, and blighted vegetation. Skelmersdale is evidently a colliery town.

Now the Lancashire coalfield is limited on the west by a north-south fault and the associated dislocation of the strata. The line of fracture runs on this map from Burscough in the north, along the west side of Knowsley Park, to Huyton. On the higher ground to the east many collieries are named. But these pits are becoming worked out. Future shaft-sinking will move steadily southwards along the concealed field and then surface subsidence is likely to take place there to the amount of 50 feet or more; clearly, this is unsuitable building land.

Dormitory Satellites, between which and the conurbation there is an immense daily flow and ebb of some 75,000 workers, may be expected from the above description of the region to fall into three series.

A coast series, northwards from Great Crosby to Southport, includes Hightown, loosely built Formby, and Ainsdale. Here, as with the industrial satellites, the problem is to preserve not only flanking open spaces over the drained peat-moss country and the open foreshore, but also transverse wedges of rural land, so that the "sounds, sights and smells," as well as the peace, of the countryside may be easily accessible to all. Hightown, Formby and Ainsdale are seen to be creeping out over the dunes and pinewoods of the seashore, to be obliterating them, as Great Crosby has already done. Great Altcar is ominous of an overflow of building on to the mosses, notwithstanding unstable foundations and difficulties of sewage disposal; here seems threatened an invasion of what the number of lanes marked on the map suggests to be a rich agricultural and pastoral land. Ribbon development seems already to be creeping northwards and southwards from Formby and Hightown.

The second series runs north-eastwards to Ormskirk along the electrified railway and the Preston road. Ribbon development has already united Maghull with both Lydiate and Aughton, and Ormskirk is joined to Town Green. To

east and west this series is protected by the two series of open mosslands.

The third series lies east and south-east of Liverpool. Huyton is conspicuously extending towards Liverpool, and only a mile of open country remains. But the district shows many private parks, large and small, so that future dormitories at Knowsley (in spite of the present lack of communications with the city) and on the higher ground of Woolton, south-east of the city, seem possible, provided that the amenities of these well-wooded pieces of green are saved from destruction at the hands of the builder.

The Farm Lands.—The close network of second-class roads that covers the map makes it clear that, in spite of the demands of industry and residence, farm life is intensive. It may be noted that at present the series of high mosses are undrained; some are completely devoid of roads and dwellings; others show a beginning of invasion by lanes, from which we may conclude that drainage and agricultural activities have begun. In the western series of low-lying mosses, however, the frequency of lanes that enter from the drier borders, as well as one or two names like Moss Lane Farm, suggest that here at least farming is well advanced, and that it takes the character of arable land rather than merely pasture; the latter seems more likely on the roadless flats north and south of Hightown. We might expect, with a concentrated market so close at hand, and one moreover that is in such close touch with the wheat lands of America, that farming here would be oriented towards market gardens and milk supplies. But actually, beyond a little of the former, the farming is of a generally mixed type, with oats, roots and fodder crops as the prevailing rotation. For milk Liverpool relies rather on the Cheshire meadows, although a third of the supplies is actually produced within the city boundaries from stall-fed cattle.

Regional Planning then aims at " zoning " the whole region. The country is studied in all its aspects ; and the particular suitability or unsuitability of each district is explored. Then and only then can scientific guidance replace haphazard development. Above all, regional planning seeks to preserve open spaces and open country for the health and recreation of the urban communities and at the same time to prevent the coalescence of industrial and residential satellites both with each other and with Liverpool.

Reference.—*The Future Development of South-west Lancashire: the report of the South-west Lancashire Joint Town Planning Advisory Committee* (University of Liverpool Press, Hodder and Stoughton, 1930).

Plate I. River Work

National Museum of Wales

A. RELIEF MODEL OF PART OF SOUTH WALES

(See page 38)

W. Hobart

B. BARGOED, RHYMNEY VALLEY

(See pages 40, 159)

R*

PLATE II. RIVER WORK

E. Buck

A. MEANDERS OF THE RIVER RIBBLE

(See page 13)

B. TRENT FLOOD-PLAIN; THE FLEET AT BESTHORPE

(See page 51)

PLATE III. ICE WORK

Valentine

A. NORTH UIST; THE WORK OF THE ICE-SHEET

(See page 67)

B. GLEN TILT; THE WORK OF THE VALLEY GLACIER

(See pages 71, 137)

PLATE IV. WIND WORK

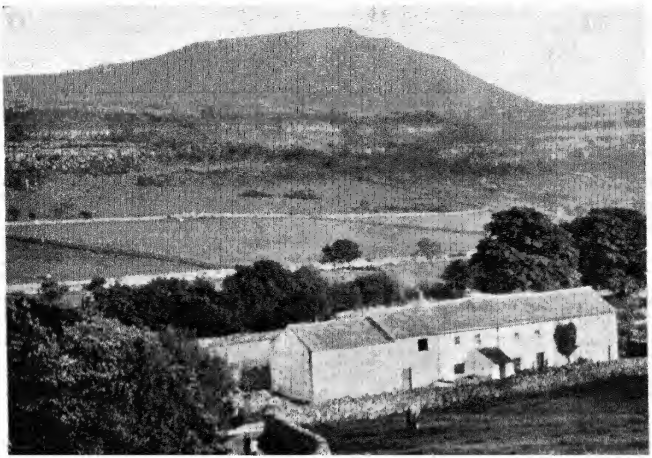
A. CULBIN SANDHILLS; DUNES ADVANCING

(See page 78)

B. CULBIN SANDHILLS; THE REAR OF THE DUNES

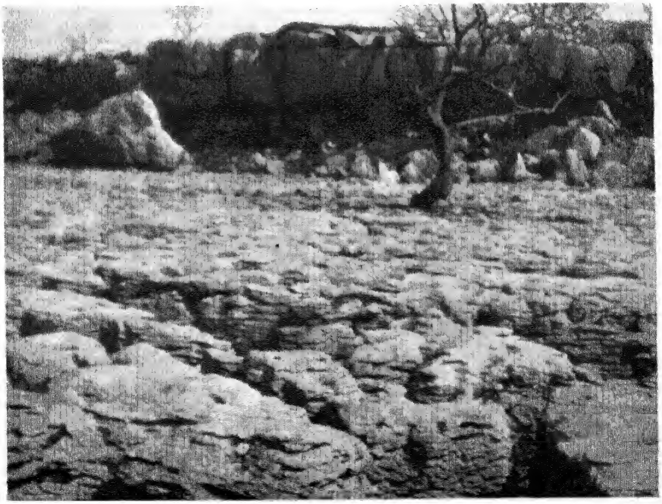
(See page 78)

Plate V. Table Mountains and Limestone



A. INGLEBOROUGH AND GRETADALE

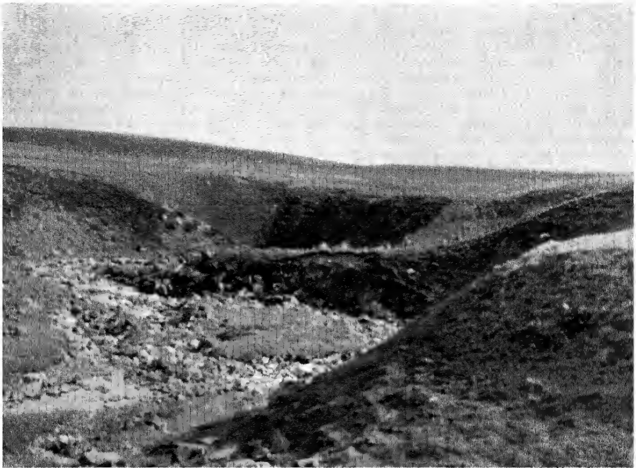
(See pages 91, 175)



B. CLINTS

(See page 95)

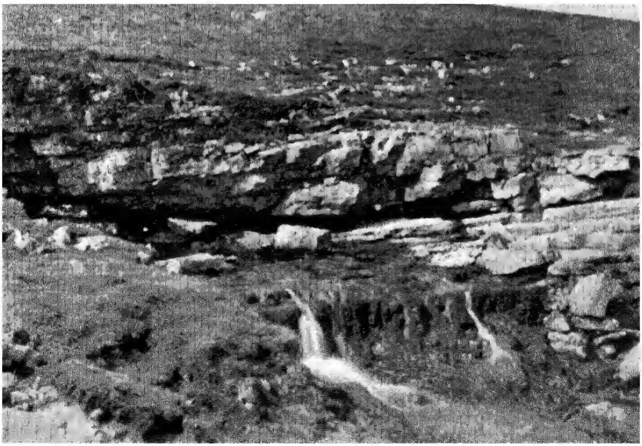
PLATE VI. LIMESTONE DRAINAGE



G. Bingley

A. FELL BECK AND GAPING GILL

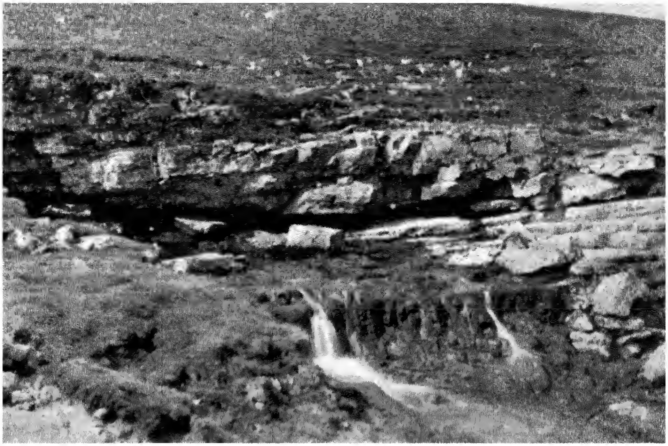
(See page 95)



G. Bingley

B. WATER ISSUE AND CRUMMOCK BECK

(See page 96)



R. W. Welch

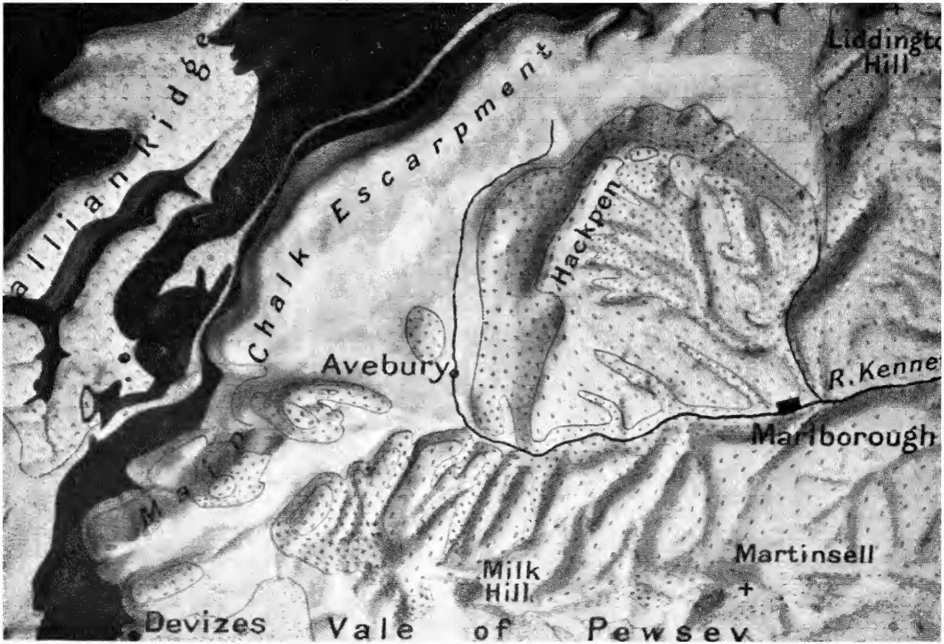
A. CORK HARBOUR

(See pages 100, 208)

B. CHALK ESCARPMENT AT BROAD TOWN, LOOKING NORTH-EAST

(See pages 110, 186)

PLATE VIII. RELIEF MODEL OF NORTH WILTSHIRE



(See page 111)

PLATE IX. A CHAPTER IN LAKE HISTORY

A. STAGE 1, ULLSWATER
(See pages 123, 130, 136, 148)

B. STAGE 2, THIRLMERE AS IT WAS
(See pages 122, 130, 148)

A. STAGE 3, BUTTERMERE AND CRUMMOCK WATER

(See pages 122, 130, 148)

B. STAGE 4, ROSTHWAITE BASIN

(See pages 122, 126, 130, 148, 150)

PLATE XI. AVEBURY CIRCLE AND VILLAGE FROM THE AIR

SOUTH

NORTH

(See pages 142, 187)

PLATE XII.

A. WATENDLATH, CUMBERLAND
(See pages 124, 148–9, 150, 152)

Valentine

B. A FIORD, LOCH ETIVE
(See pages 203, 236)

PLATE XIII. MARINE EROSION

A. STAGE I, STAIR HOLE

(See pages 137, 226)

Stair Hole

Surrey Flying Services, Croydon

B. STAGE 2, LULWORTH COVE

(See pages 227, 233)

A. STAGE 3, MUPE ROCKS AND WORBARROW BAY
(See page 227)

B. A SHORE PLATFORM, BROAD BENCH
(See pages 137, 225)

PLATE XV. BEACH AND PROMONTORY, NORTH DEVON

Flatters & Garnett

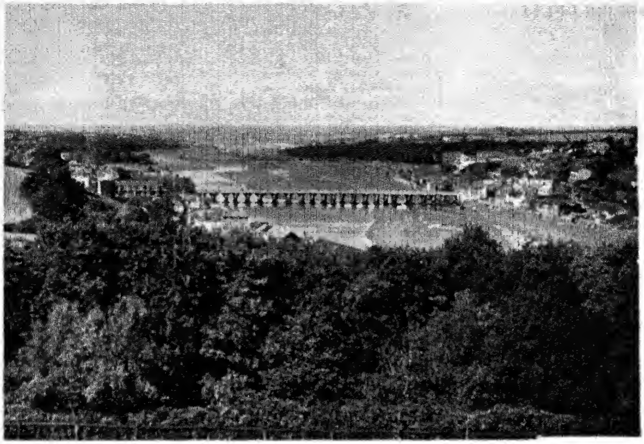
A. MORTE POINT

(See page 221)

R. L. Knight

B. WOOLACOMBE SANDS

(See page 222)



R. L. Knight

A. BIDEFORD AND THE RIVER TORRIDGE

(See page 243)

Aerofilms

B. LIVERPOOL LANDING STAGE

(See page 250)

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